

Figure 88. FAA L-880 Style A (Constant Voltage) System Wiring Diagram.

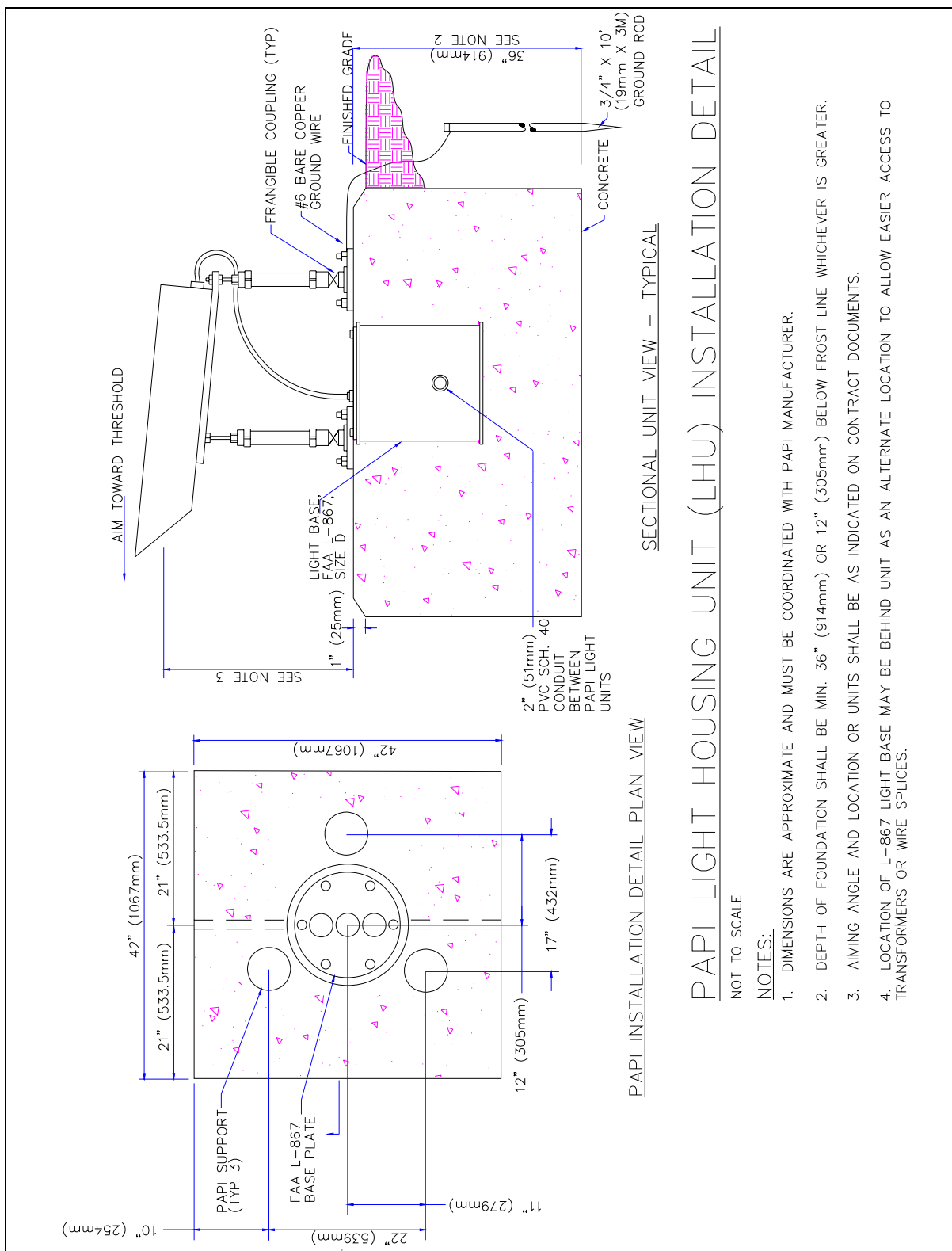


Figure 89. PAPI Light Housing Unit (LHU) Installation Detail.

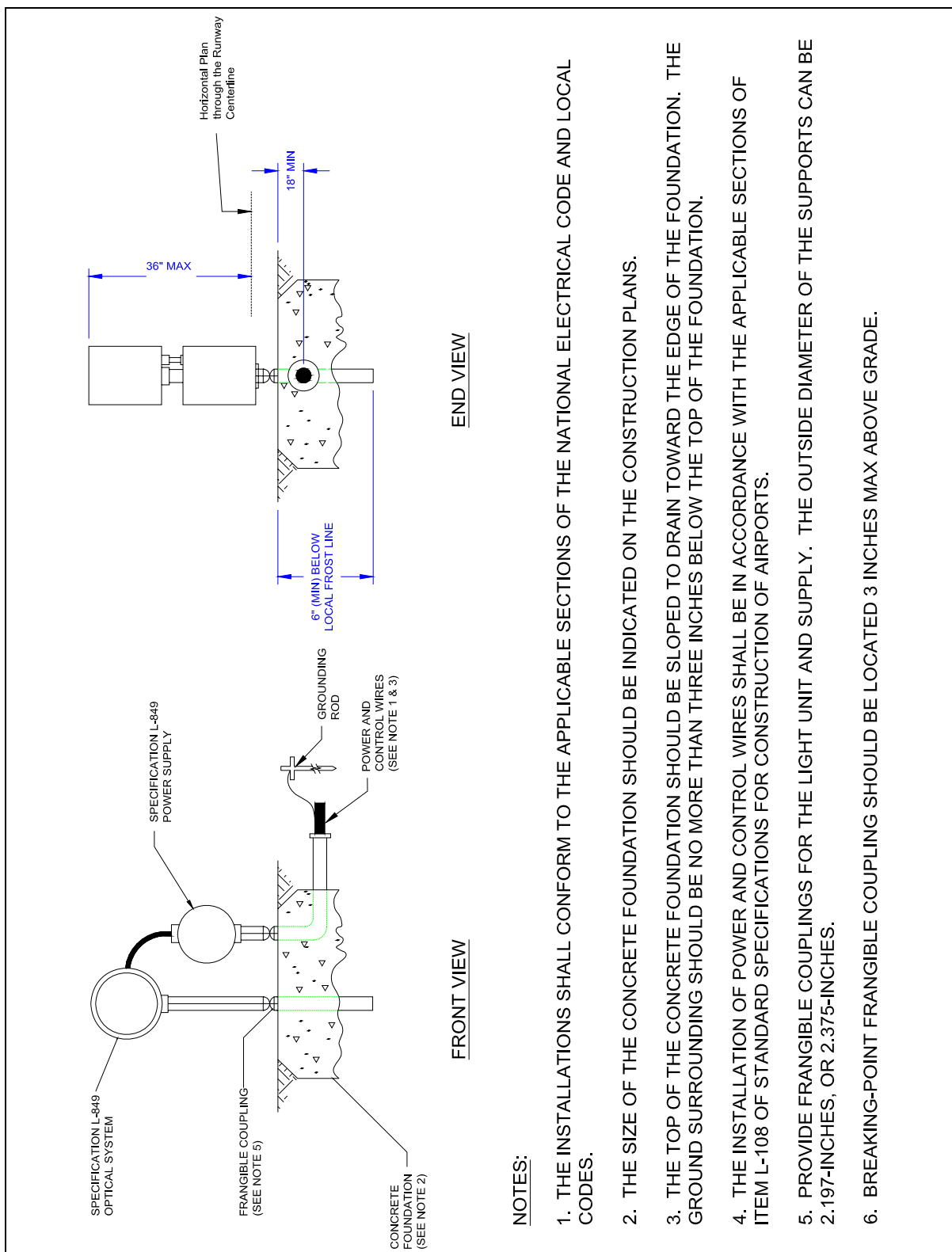


Figure 90. Typical Installation Details for Runway End Identifier Lights (REILs).

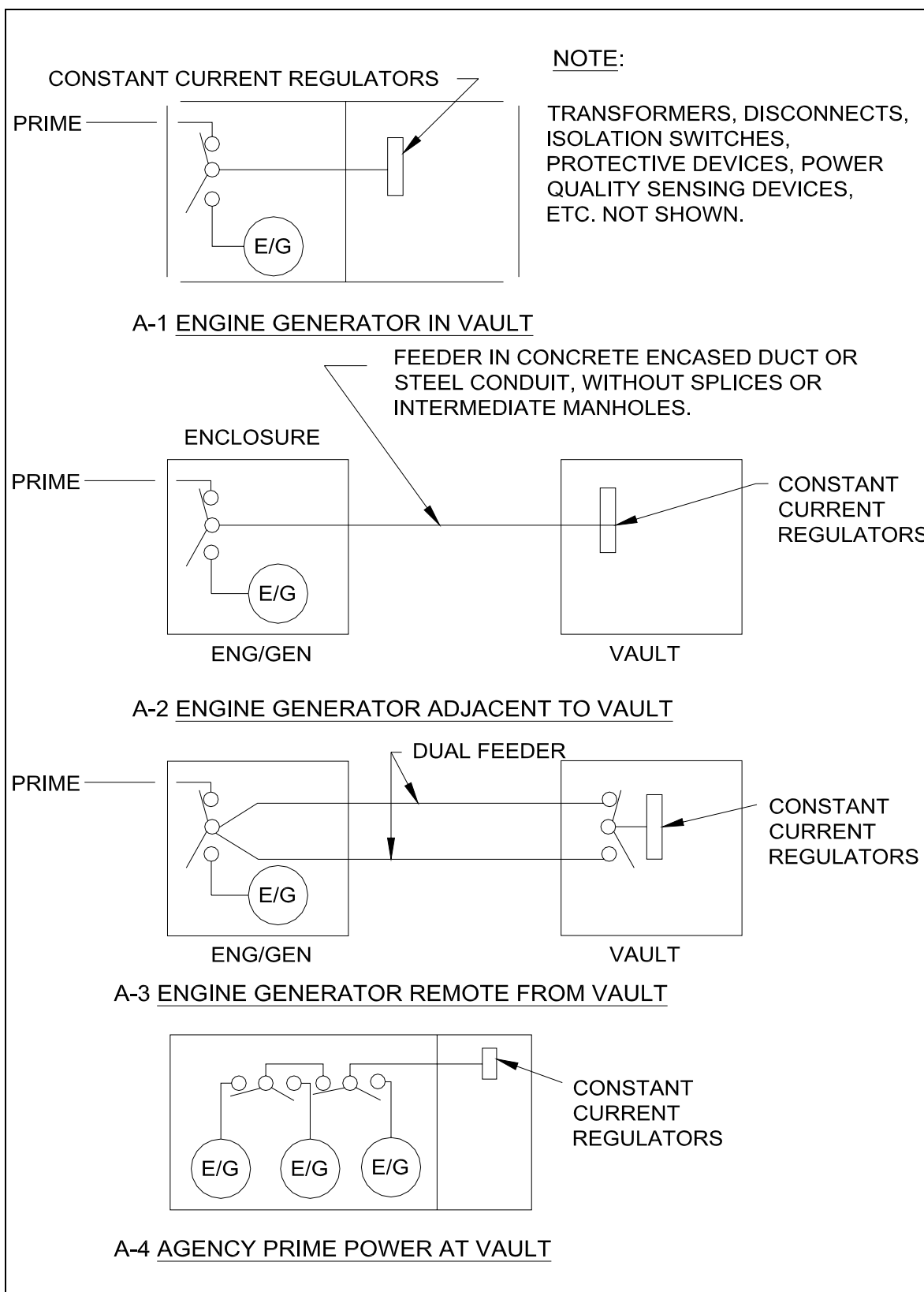


Figure 91. Configuration "A" Electrical Power.

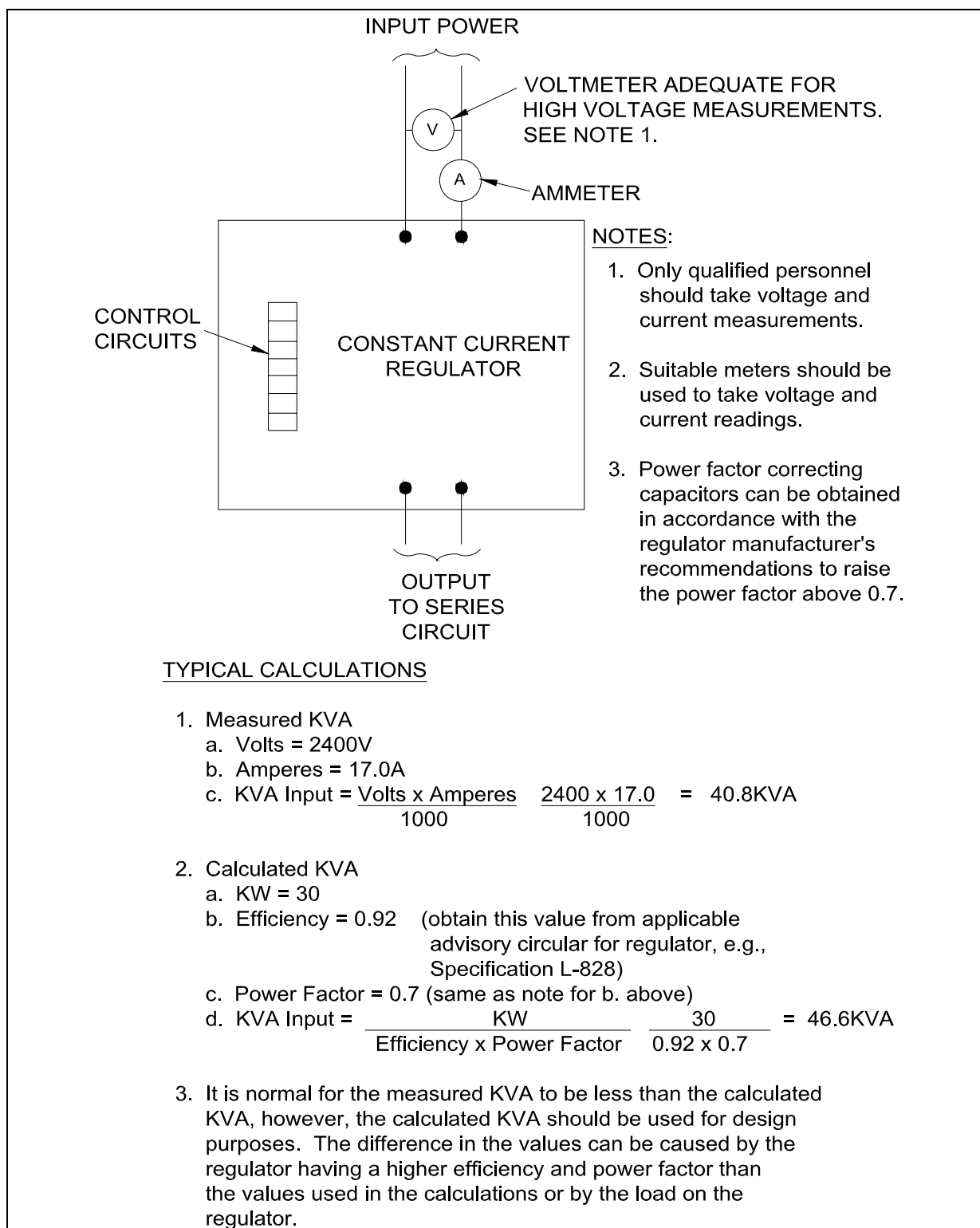


Figure 92. Typical KVA Input Requirements.

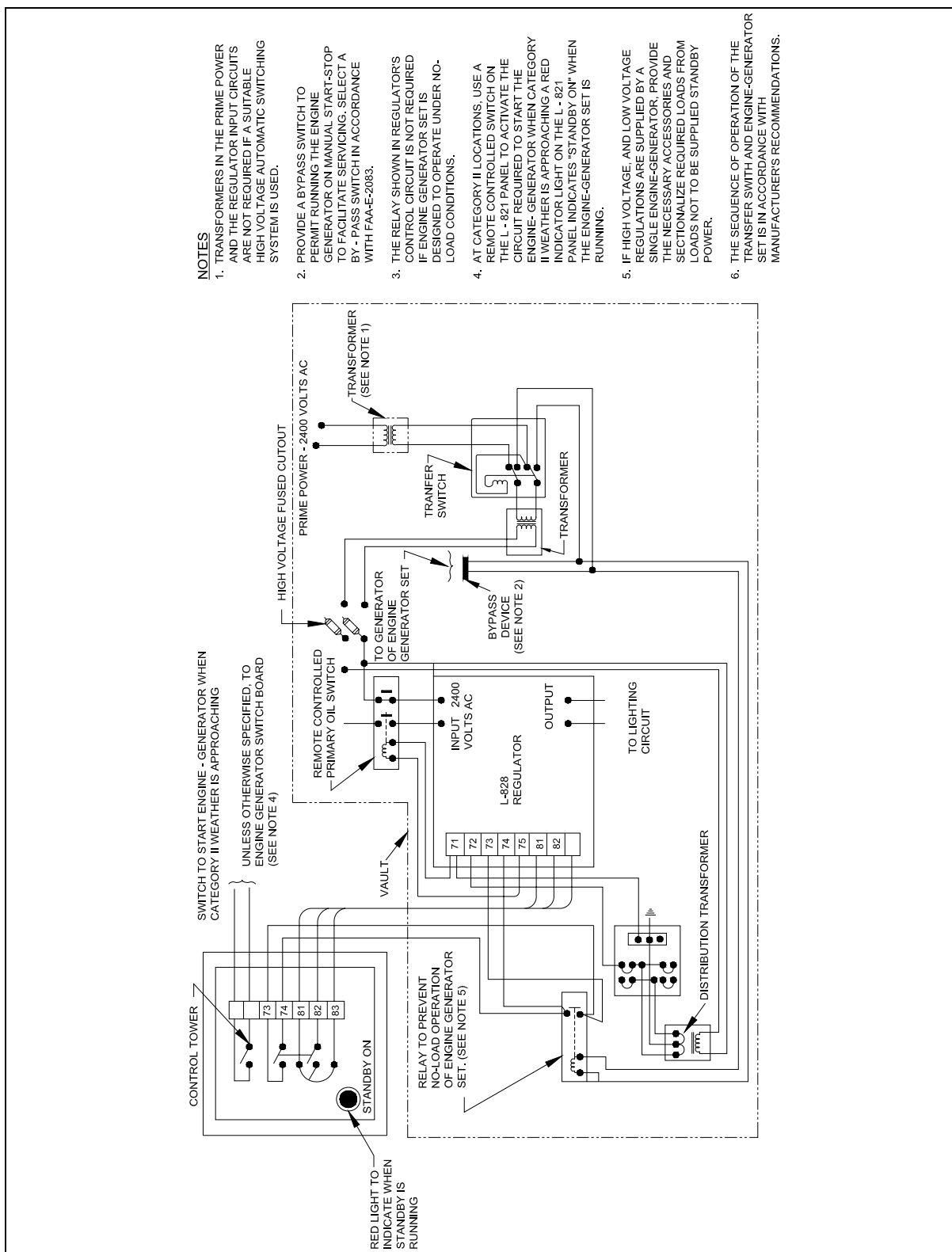


Figure 93. Typical Wiring Diagram for Configuration "A" Electrical Power.

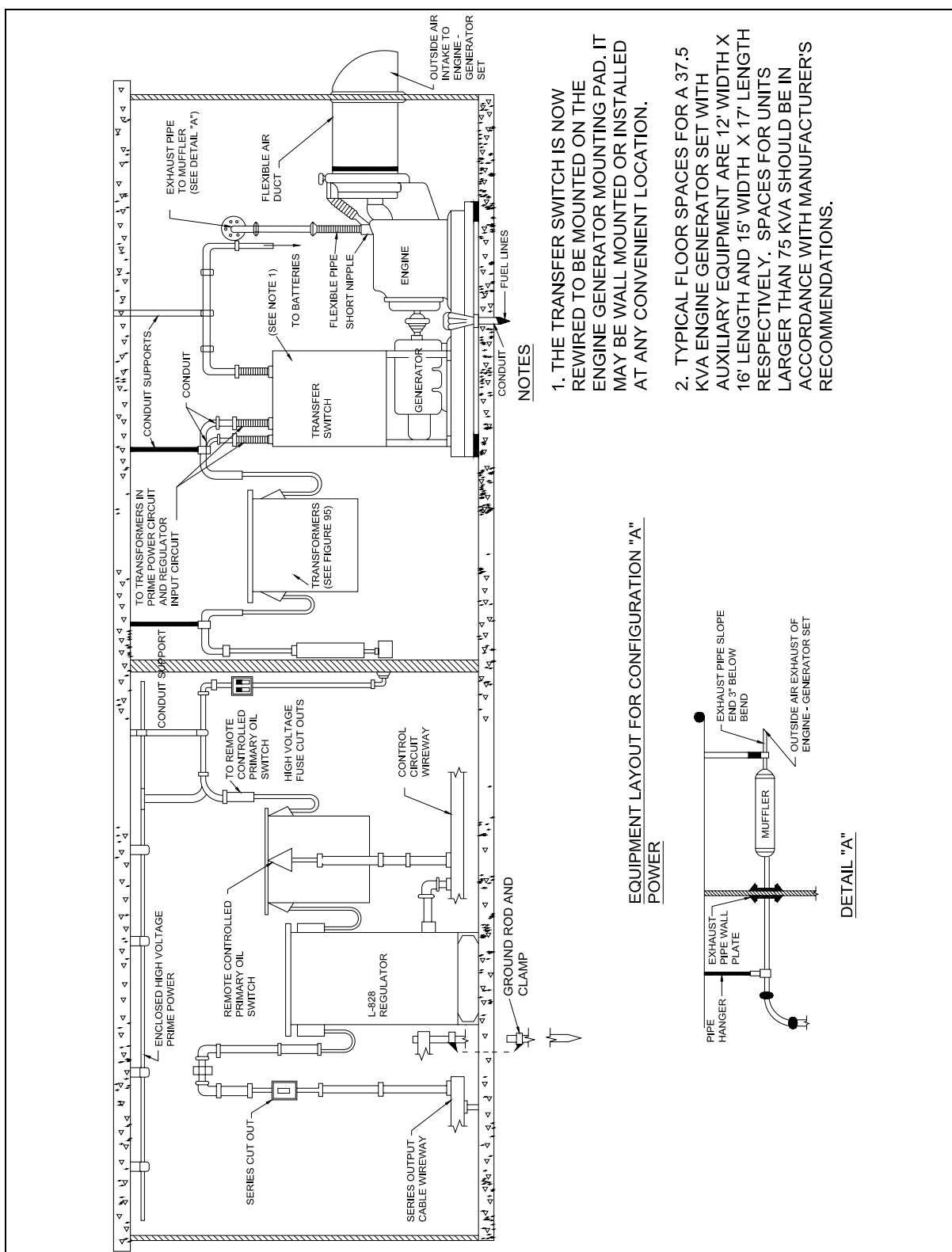


Figure 94. Typical Equipment Layout for Configuration "A" Electrical Power.

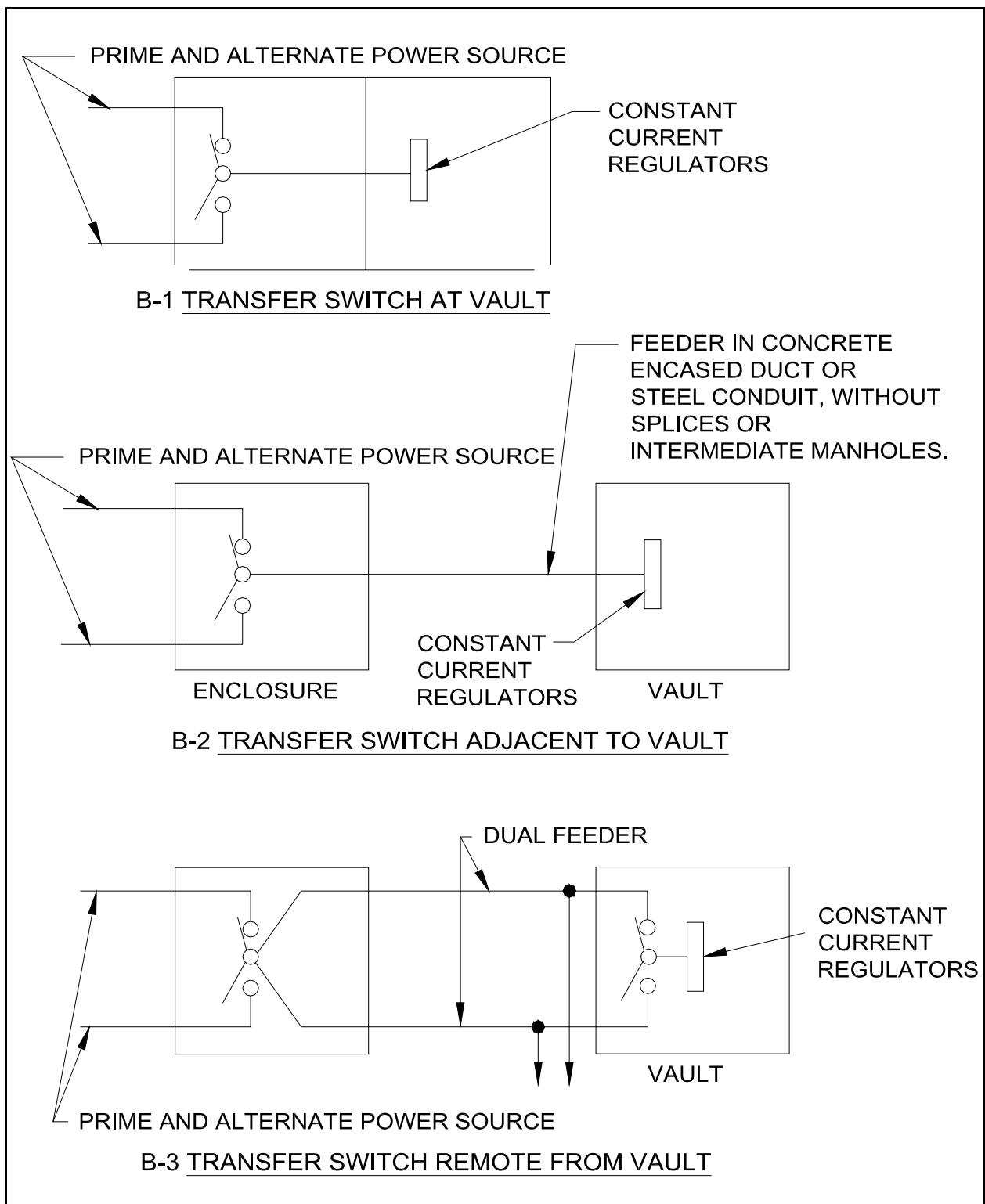


Figure 95. Configuration “B” Electrical Power.



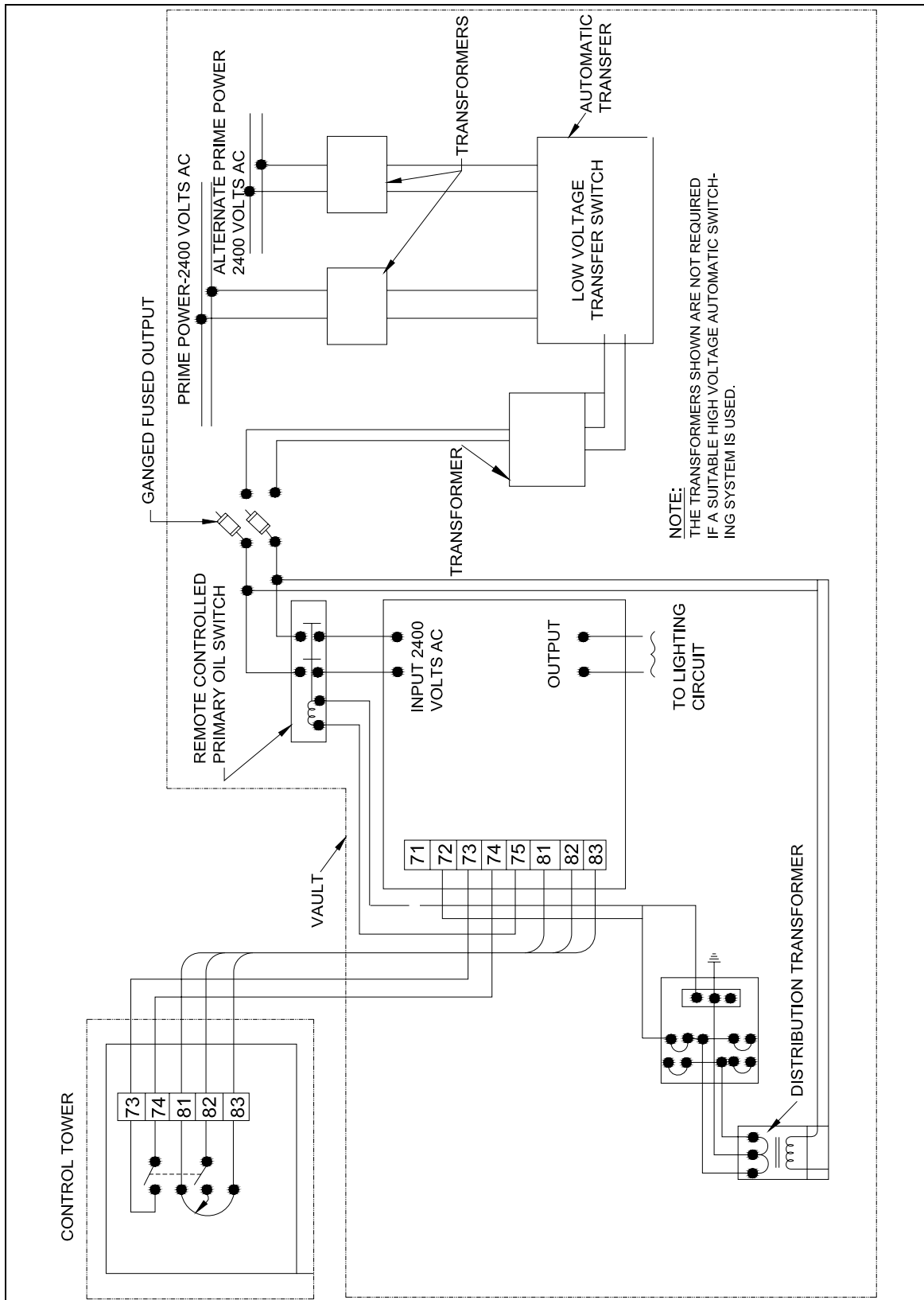


Figure 96. Typical Wiring Diagram for Configuration "B" Electrical Power.

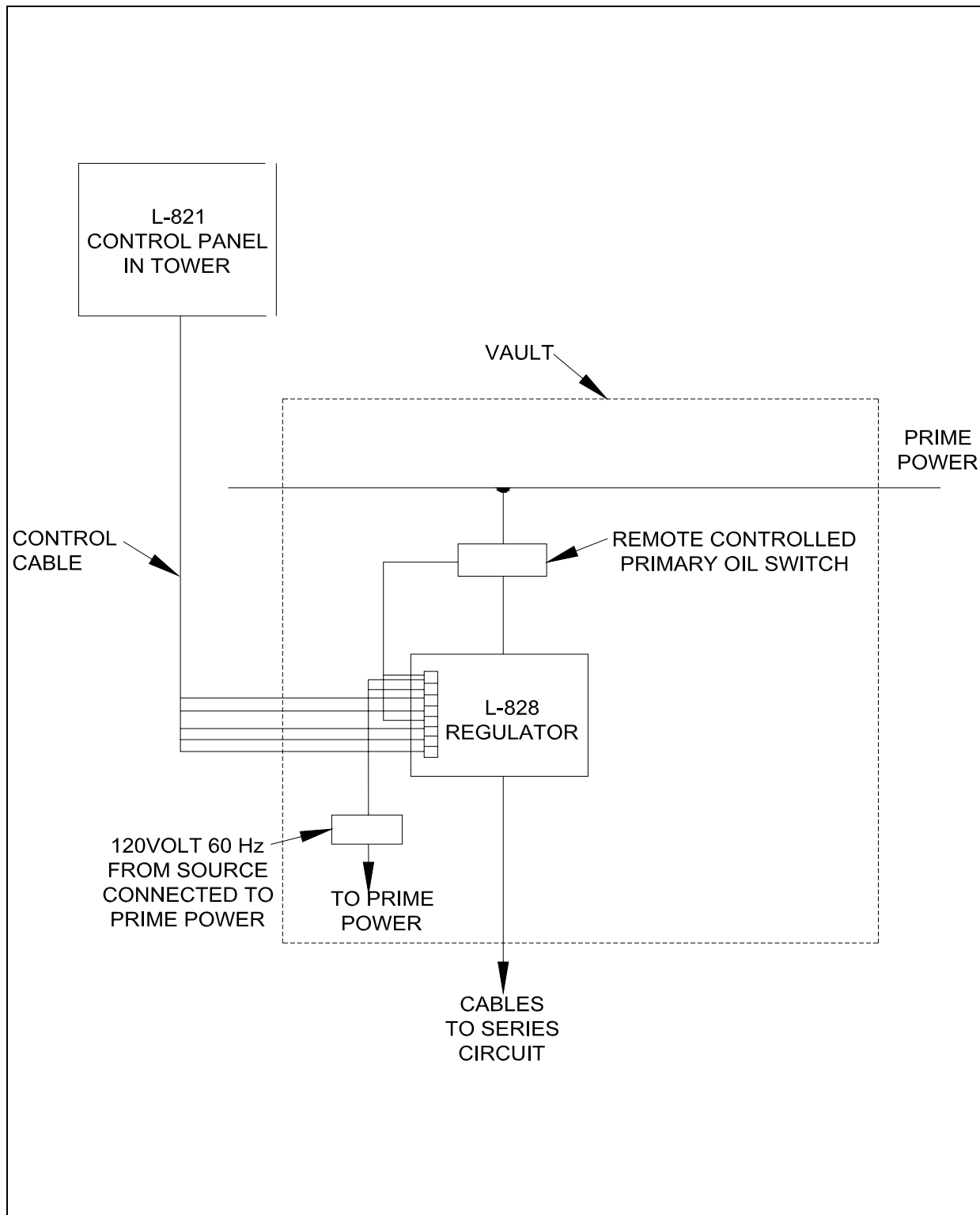


Figure 97. Typical Wiring Diagram for Configuration "C" Power.

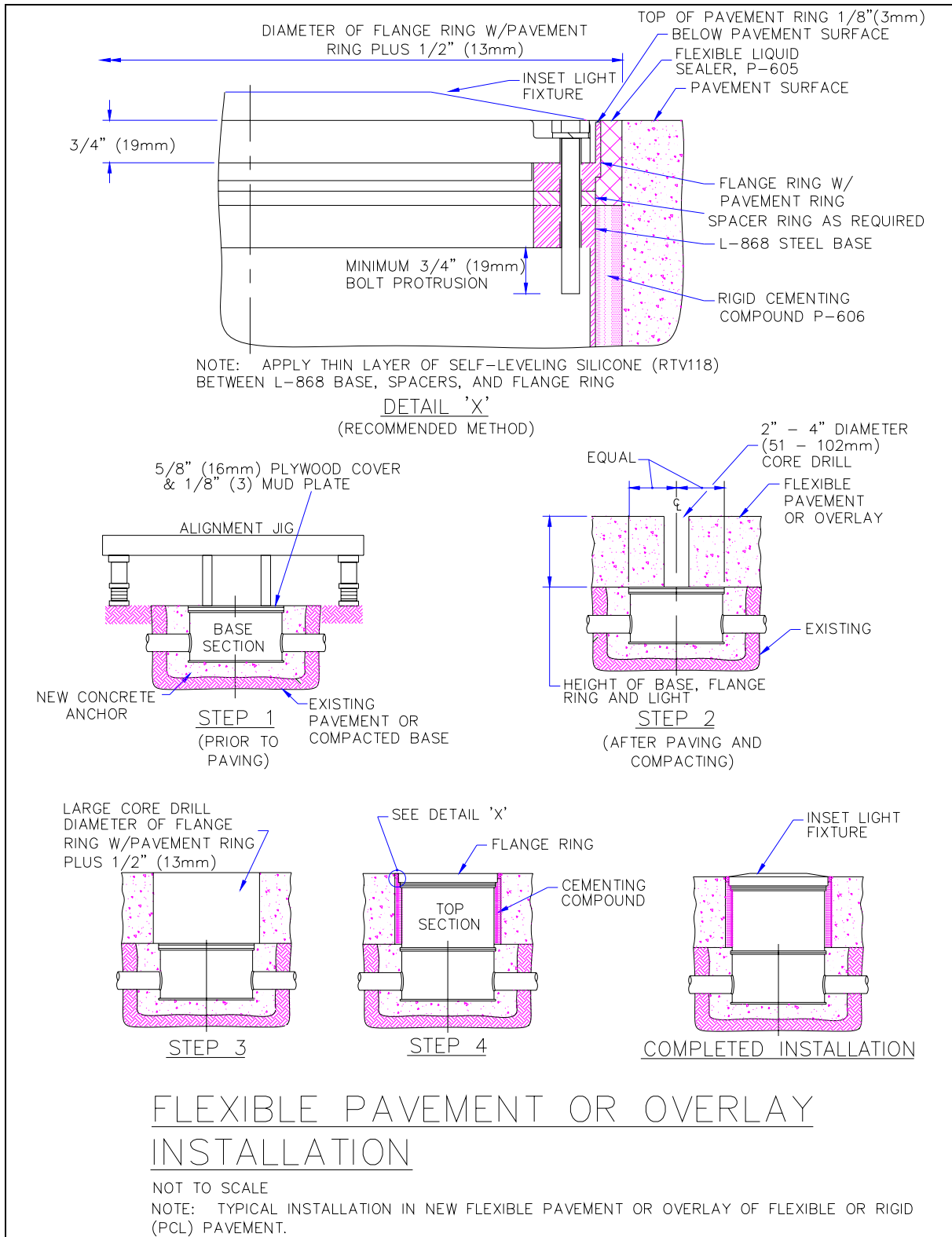


Figure 98. Flexible Pavement or Overlay Installation.

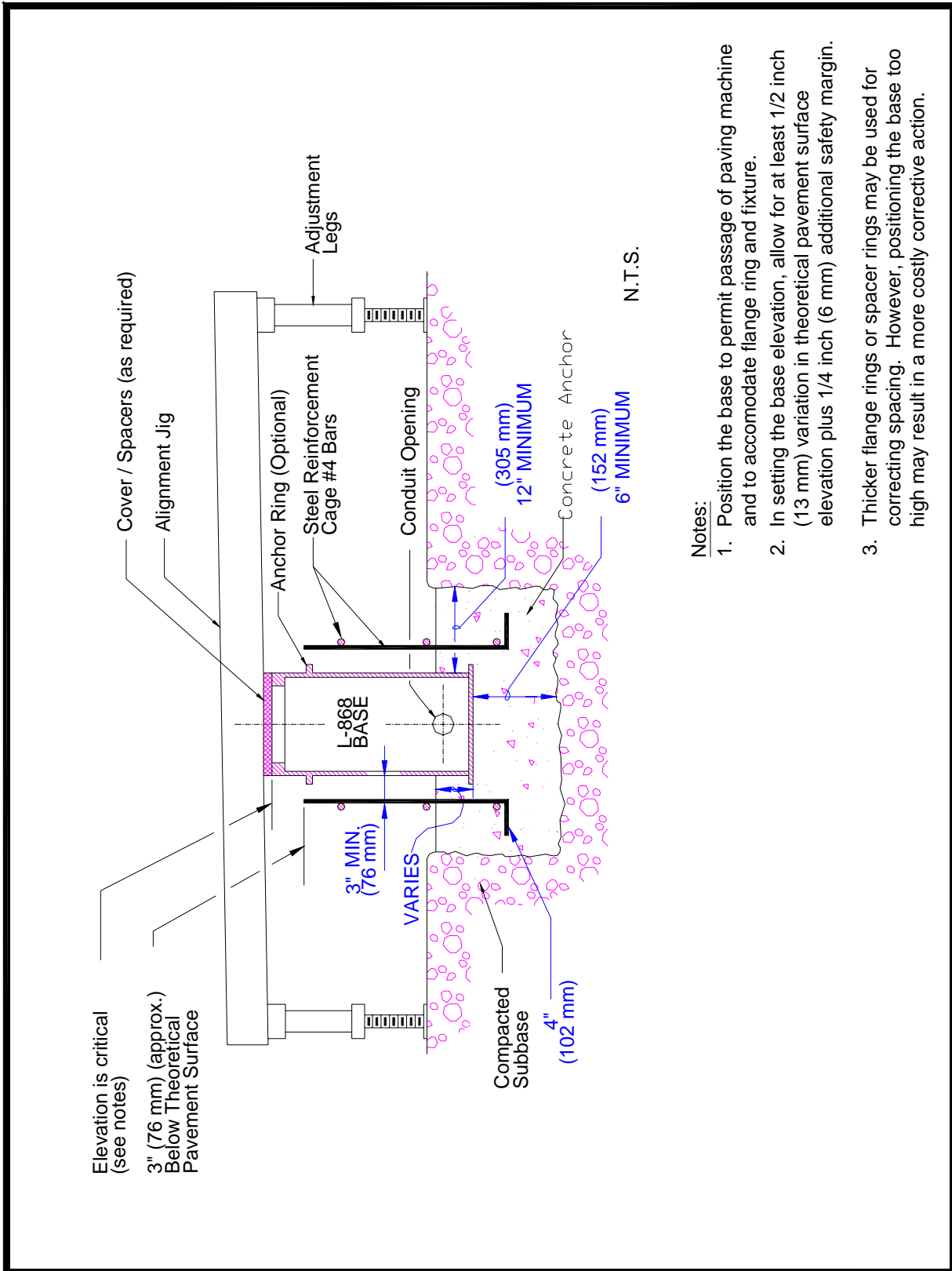


Figure 99. Use of Alignment Jig, No Reference Edge Available, Non-adjustable Base and Conduit System.

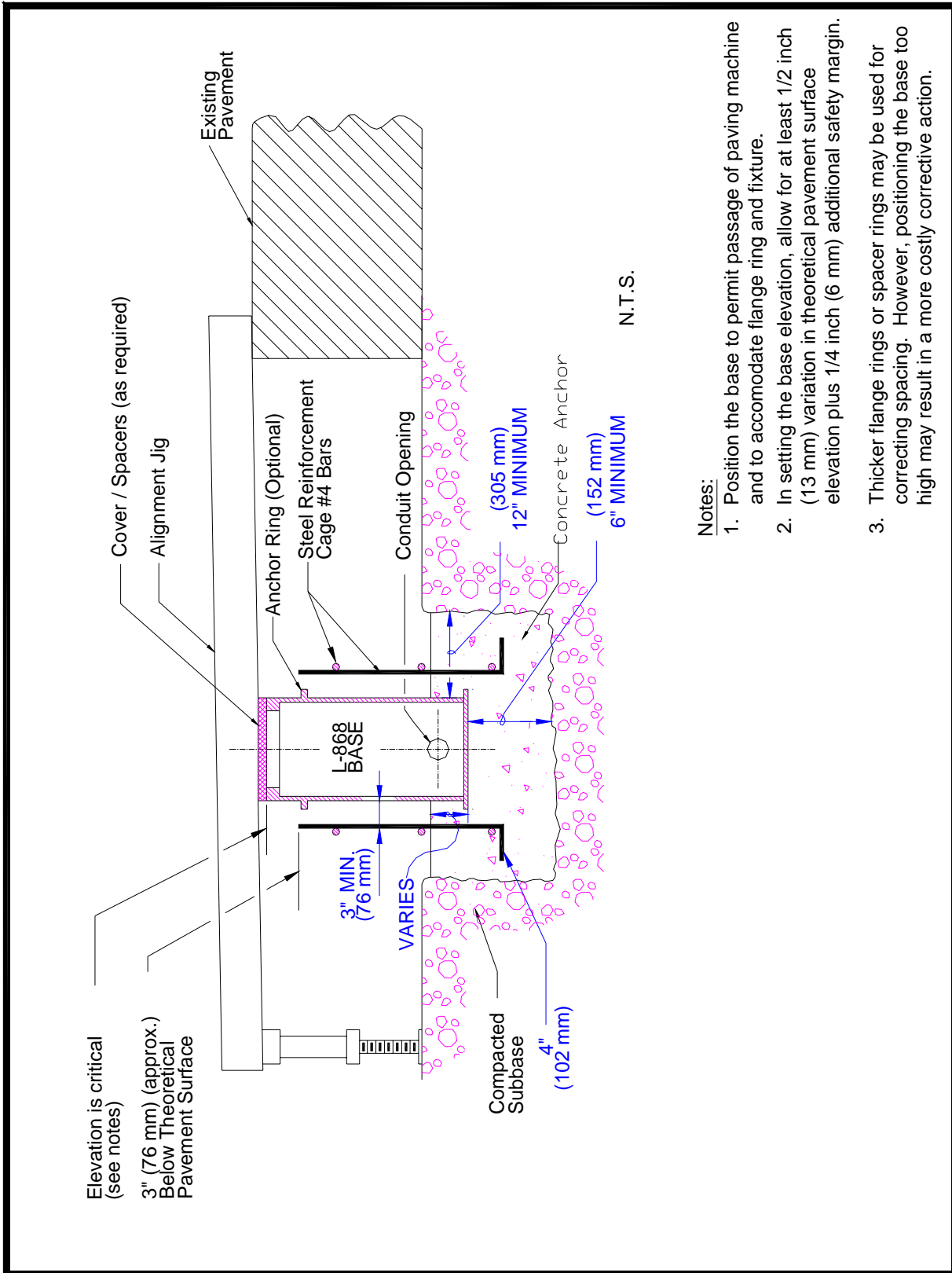
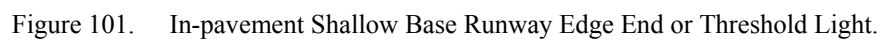


Figure 100. Use of Alignment Jig, Reference Edge Available, Non-adjustable Base and Conduit System.



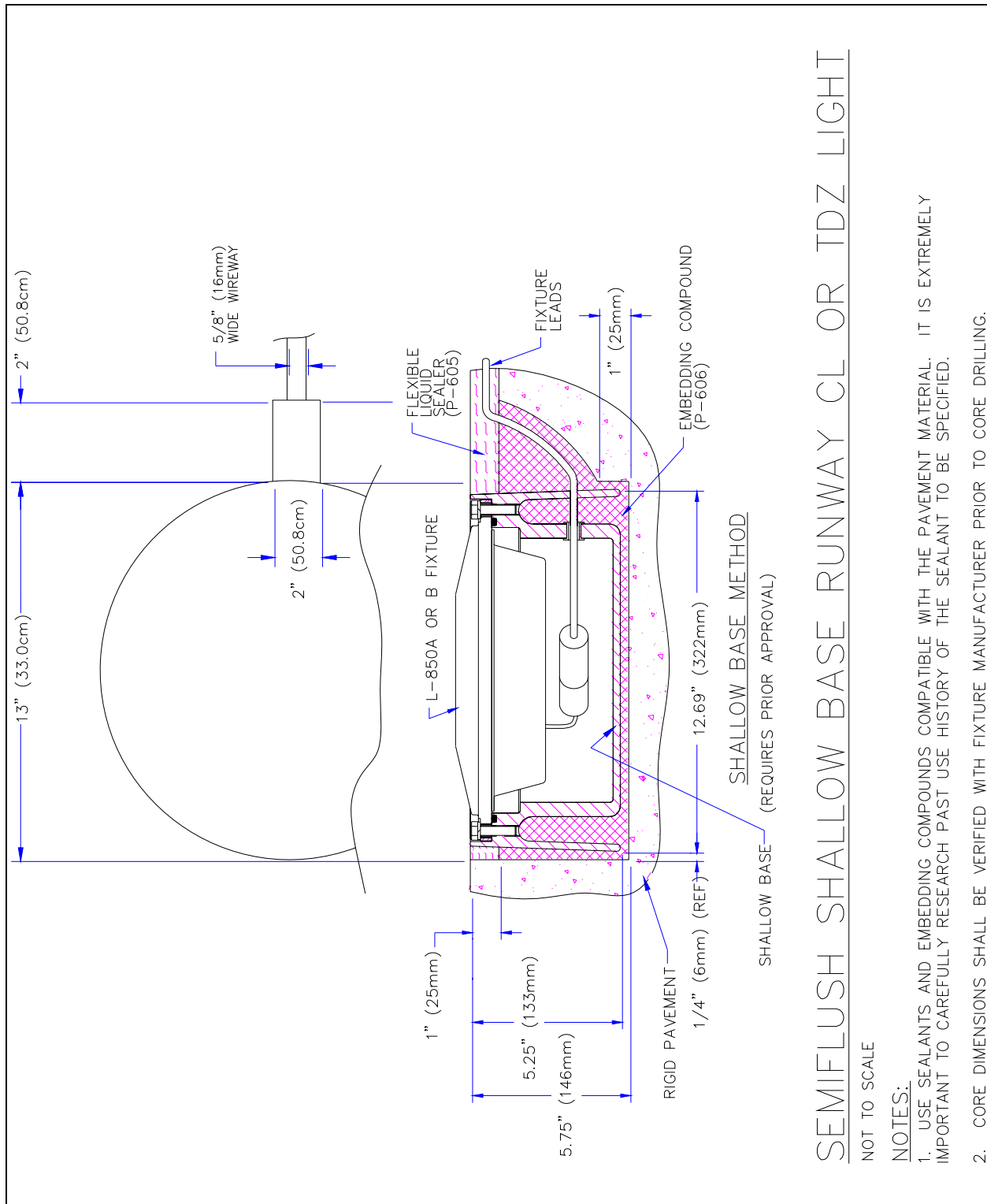


Figure 102. In-pavement Shallow Base Runway Centerline or TDZ Light.

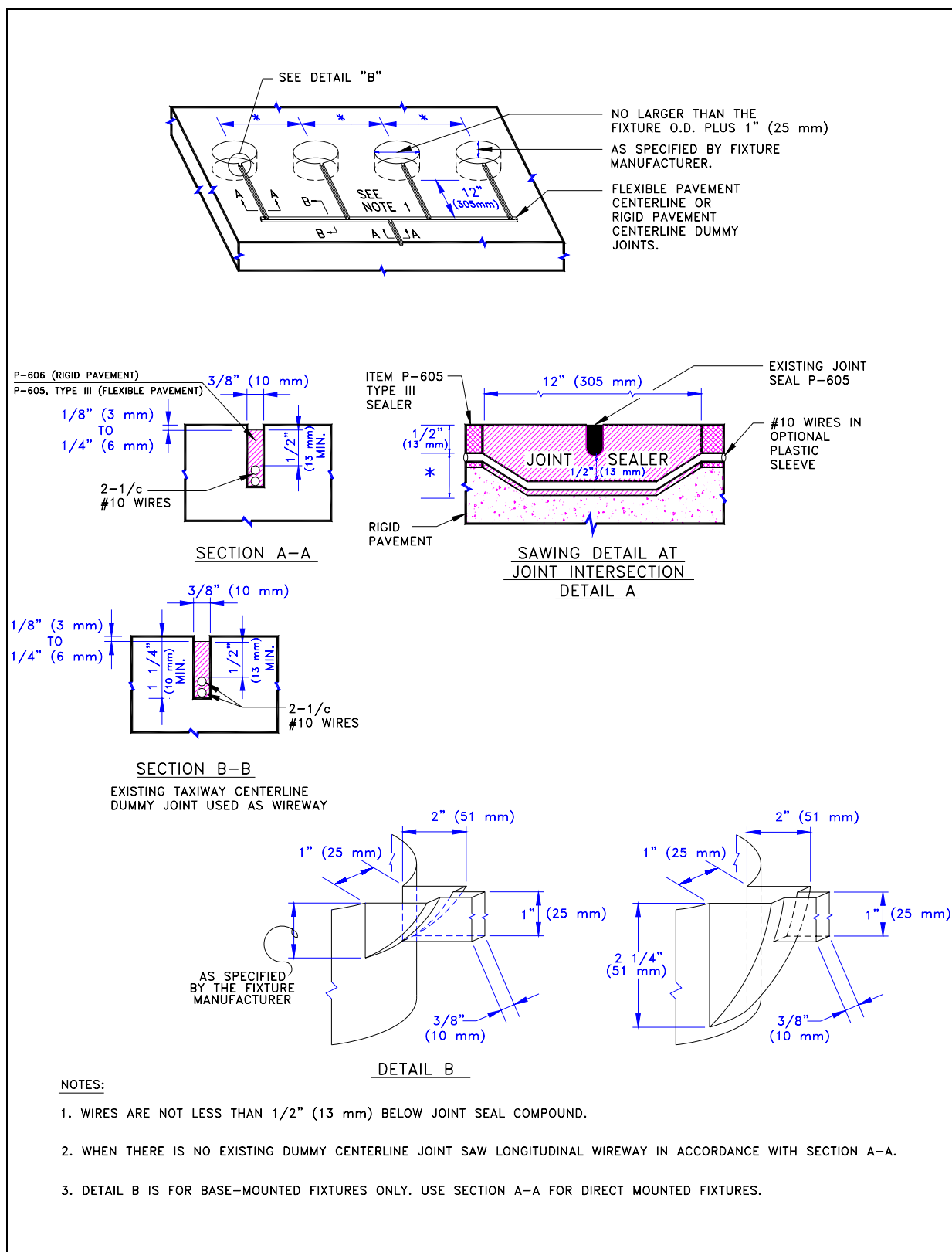


Figure 103. Sawing and Drilling Details for In-Pavement Taxiway Centerline Lights.



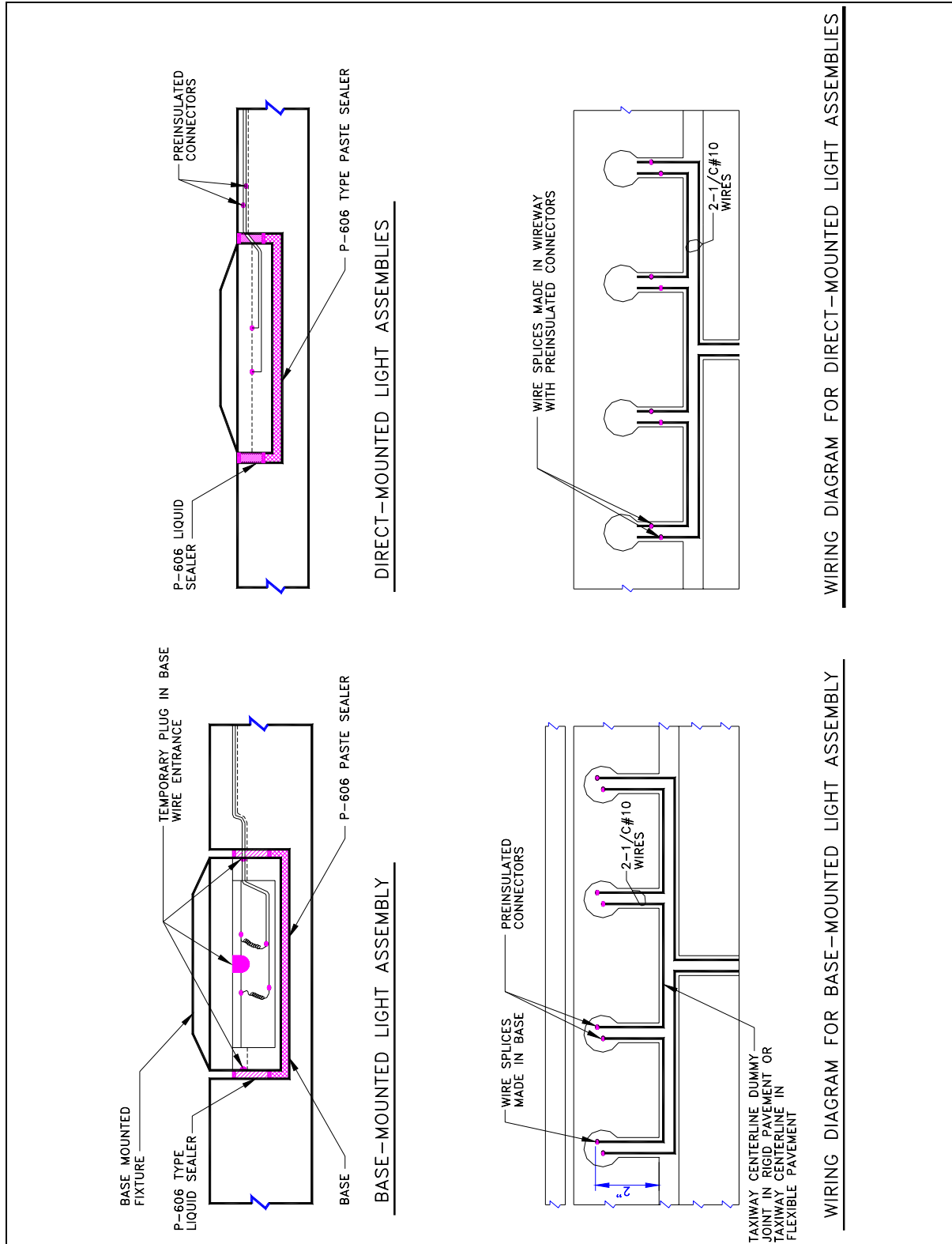


Figure 104. Wiring Details for Direct- and Base-Mounted Taxiway Centerline Lights.

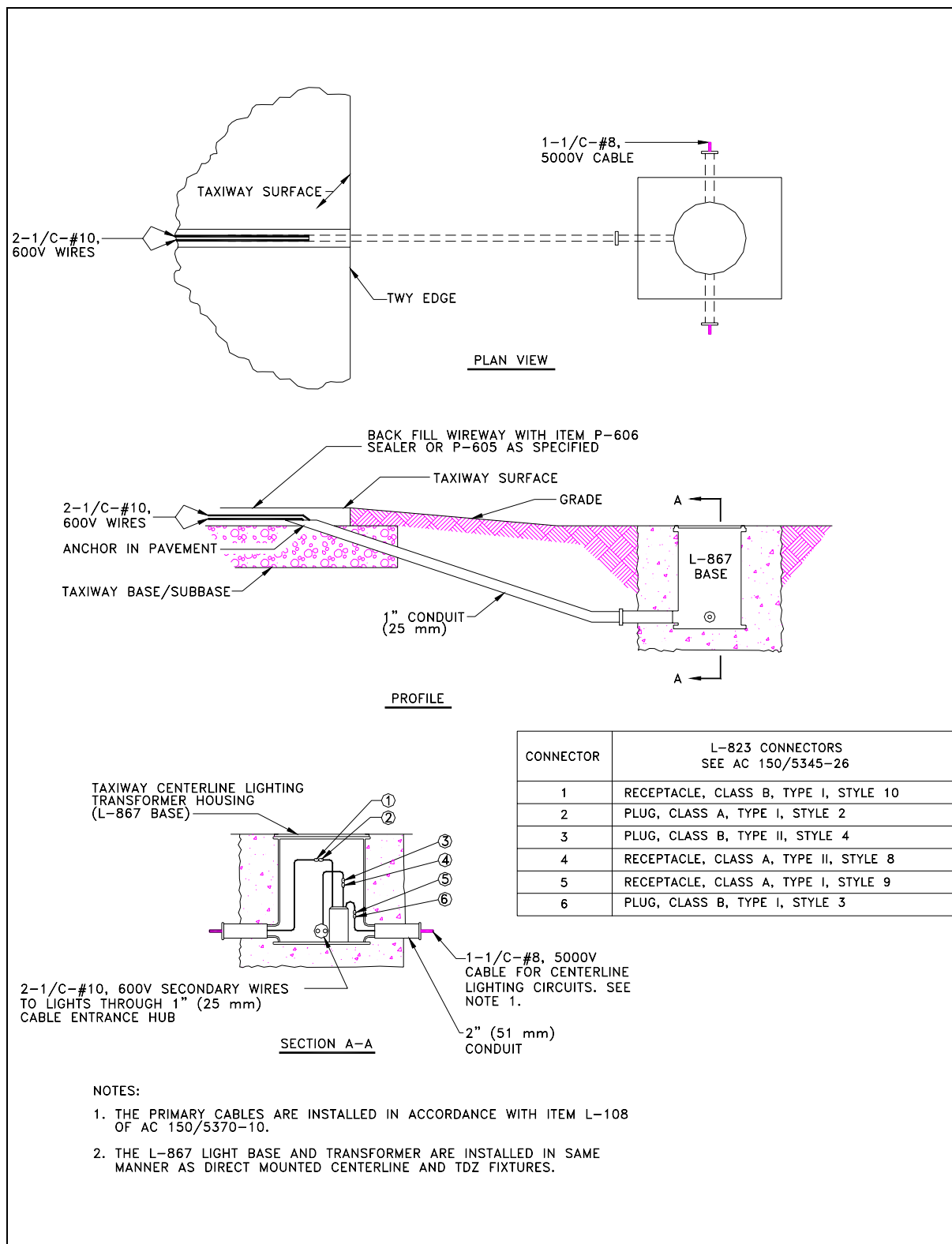


Figure 105. Typical Transformer Housing and Conduit Installation Details for Taxiway Centerline Lights.

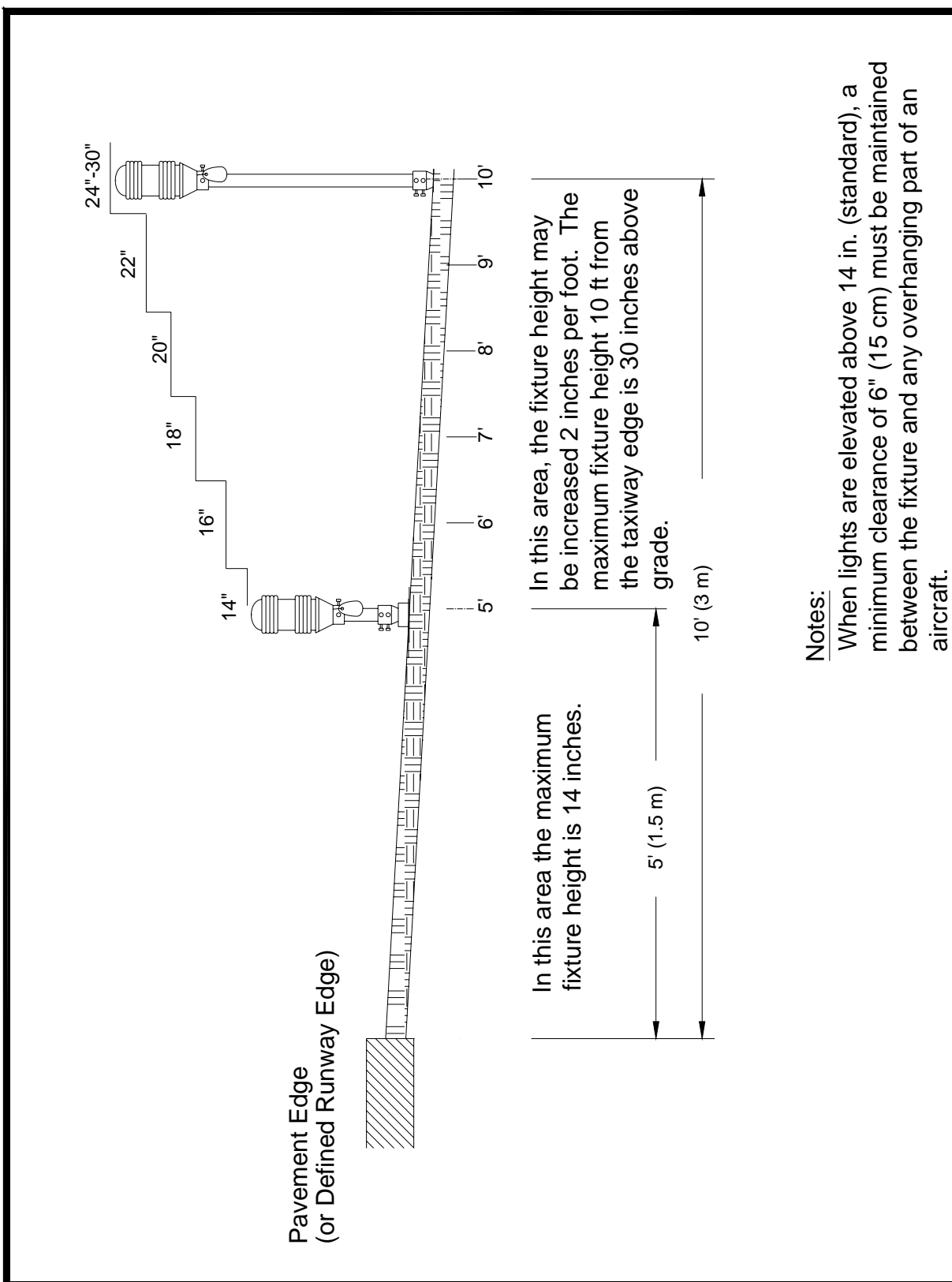


Figure 106. Adjustment of Edge Light Elevation for High Snowfall Areas.

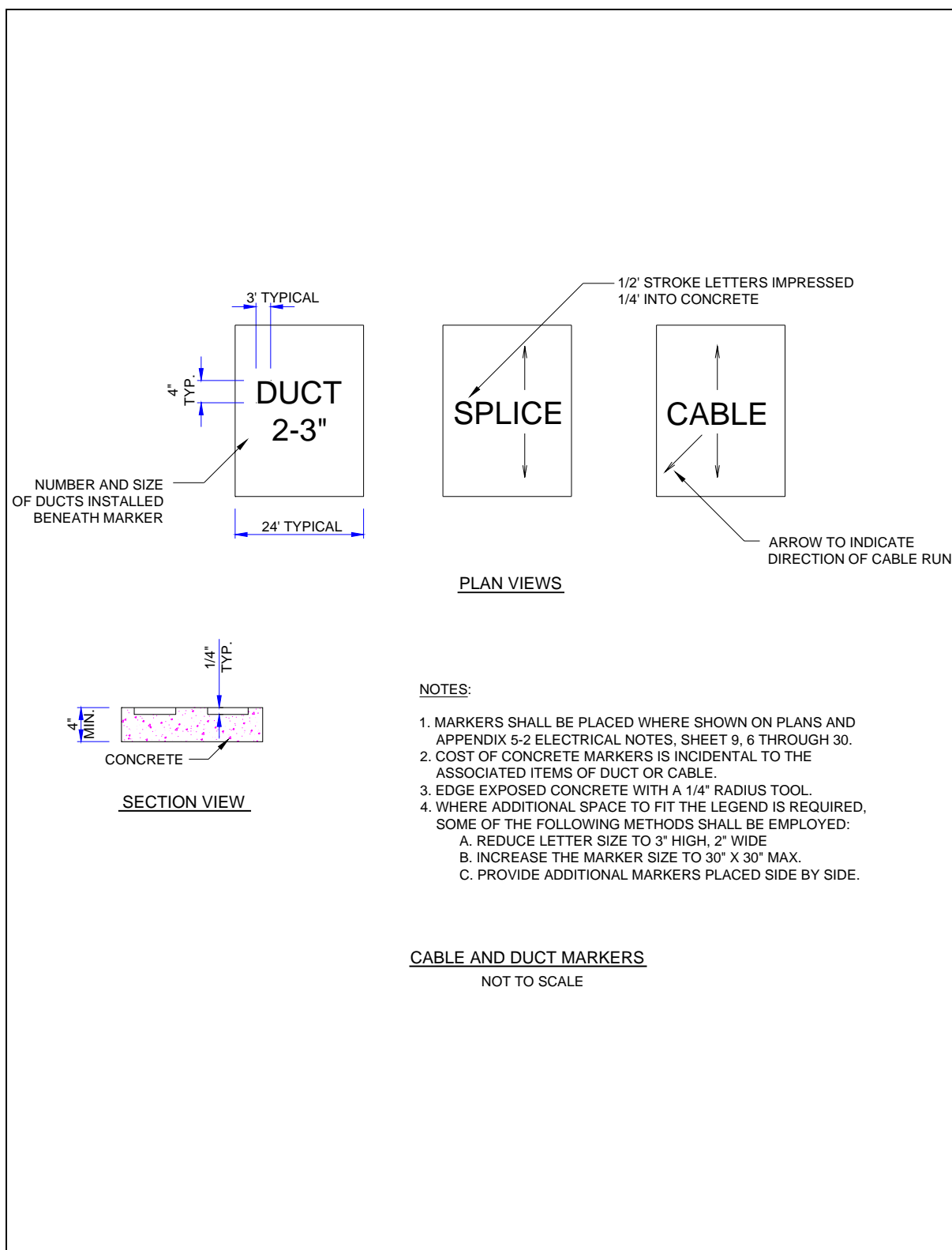


Figure 107. Cable and Duct Markers.

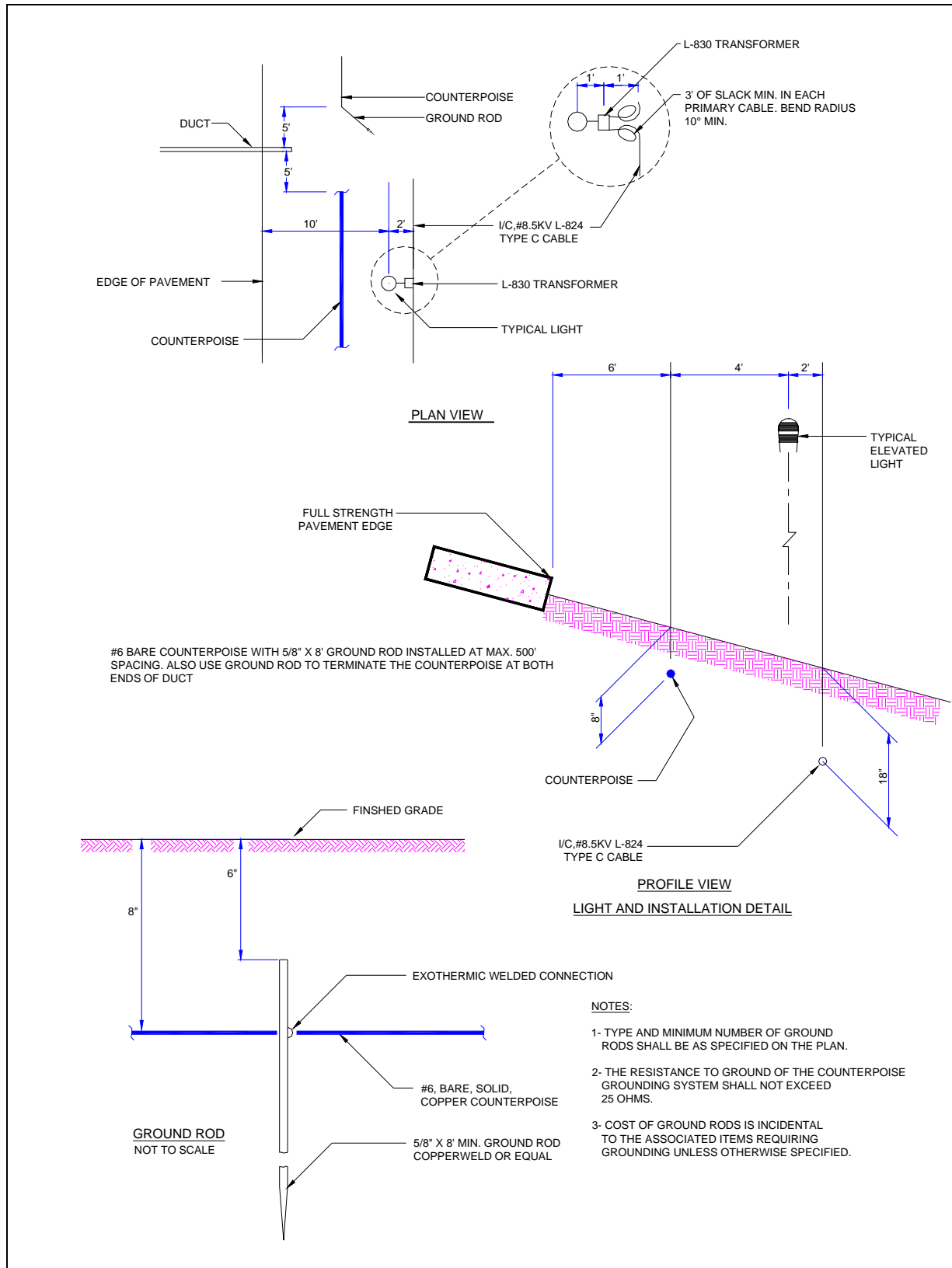


Figure 108. Counterpoise Installation.

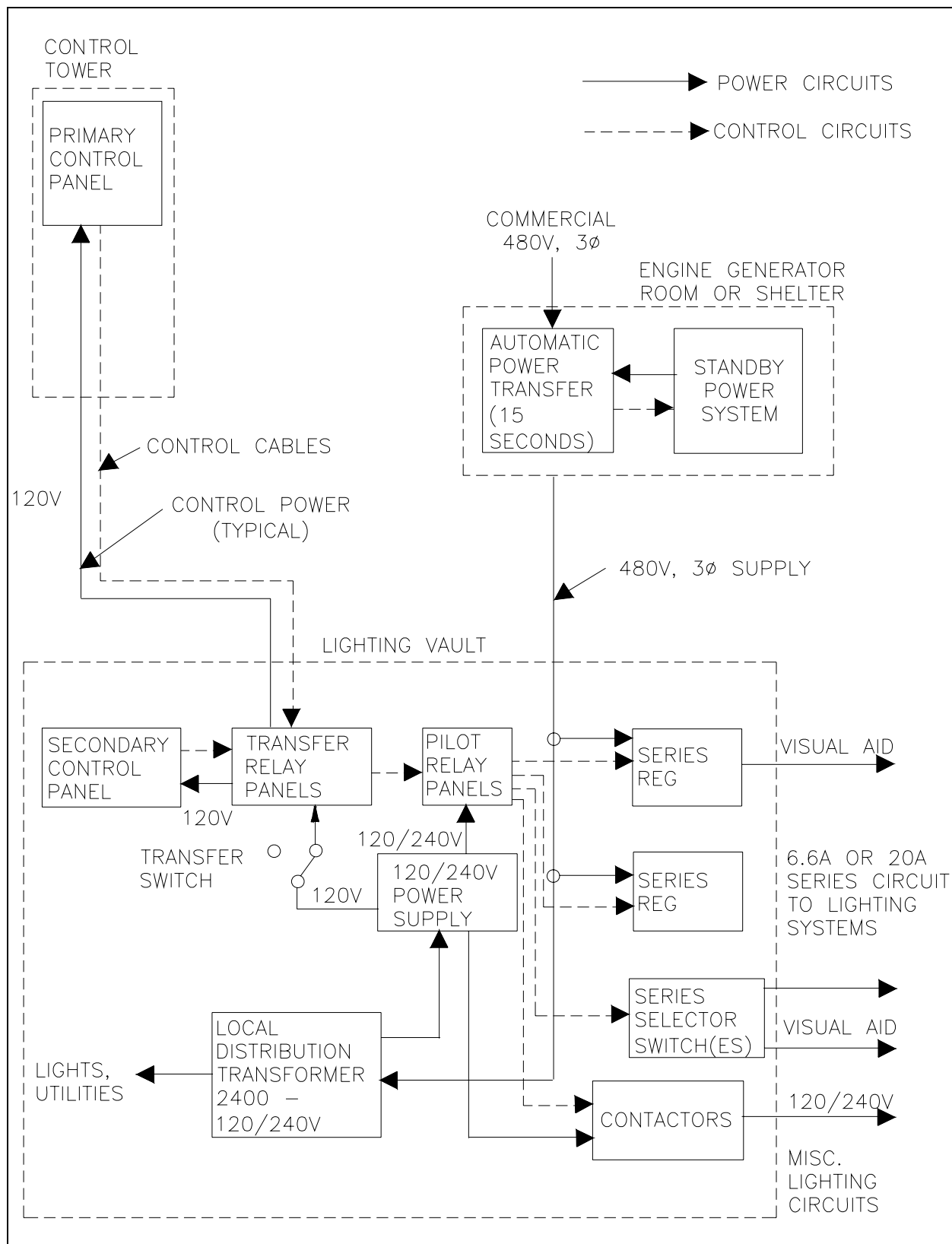


Figure 109. Power and Control System Block Diagram.

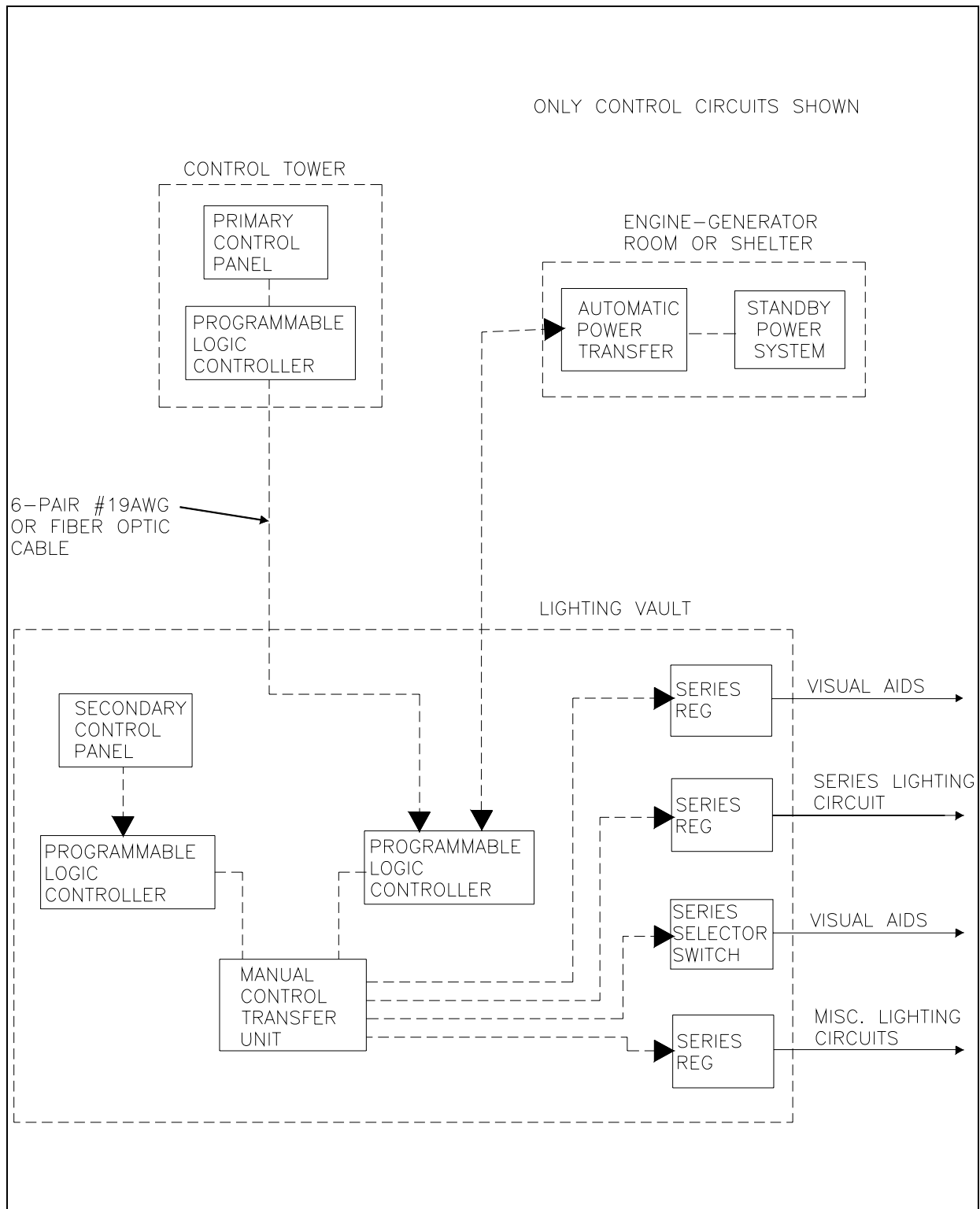


Figure 110. Typical PLC Control System Block Diagram.

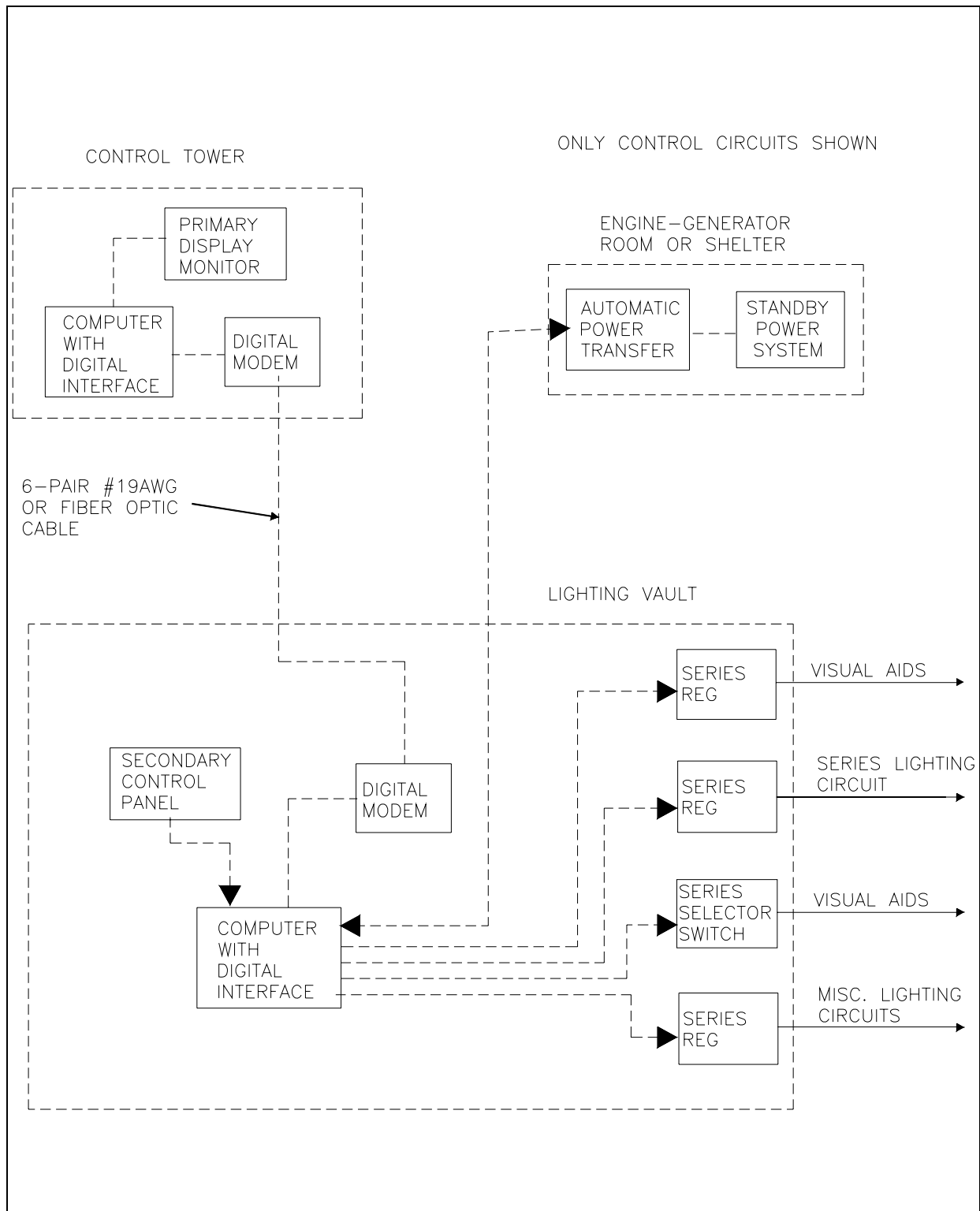


Figure 111. PC Control System Block Diagram.



**APPENDIX 2. AIRPORT TECHNICAL ADVISORY.**

Subject: Electromagnetic interference (EMI) induced by L-828, SCR Type, Constant Current Regulators (CCRs).

Some airports have experienced excessive levels of EMI which degrades the performance of some of the airport's air navigational systems, i.e. RVRs, glide slope localizers, ATCTS, etc., SCR type, L-828, CCRs, are the likely sources of EMI due to their inherent operating characteristics. The following are some of the cautionary steps that may help decrease EMI and/or its adverse effects in the airport environment.

1. Cables for airfield lighting circuits should not be installed in the same conduit, cable duct or duct bank as control and communication cables.
2. Cables for airfield lighting systems should not be installed such that they cross control and/or communications cables.
3. In some cases, harmonic filters may be installed at the regulator output to reduce the EMI emitted by the CCR. These filters are available from some CCR manufacturers.
4. Spare control and communications cables should be grounded.
5. Inform manufacturers, designers, engineers, etc., about the existing navigational equipment and the potential for interference.
6. Electromagnetic compatibility between new equipment and existing equipment should be a requirement in project contracts. Operational acceptance test(s) may be required to verify compliance.

The FAA is modifying AC 150/5345-10E, *Specification for Constant Current Regulators and Regulator Monitors*, to decrease EMI in the airport environment.

For more information contact the FAA Office of Airport Safety and Standards, FAA Engineering, 800 Independence Avenue, SW, Washington, DC 20591.

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**APPENDIX 3. TERMS & ACRONYMS.**

<b>AC</b>	Alternating Current
<b>Accelerate-stop distance available</b>	The runway plus stopway length declared available and suitable for the acceleration and deceleration of an airplane aborting a takeoff
<b>AIP</b>	Airport Improvement Program
<b>ALD</b>	Available Landing Distance
<b>ALS</b>	Approach Lighting System
<b>ALSF</b>	Approach Lighting System with Sequenced Flashing Lights
<b>ANSI</b>	American National Standards Institute
<b>ASDA</b>	Accelerated-stop distance available
<b>ASTM</b>	American Society for Testing and Materials
<b>ATC</b>	Air Traffic Control
<b>ATCT</b>	Air Traffic Control Tower
<b>CAN/CSA</b>	Canadian Standards Association
<b>CAT I</b>	Facility providing operation down to 200 feet (61 m) decision height and runway visual range not less than 2,400 feet (732 m)
<b>CAT II</b>	Facility providing operation down to 100 feet (30 m) decision height and runway visual range not less than 1,200 (366 m) feet
<b>CAT III</b>	Facility providing operation with no decision height limit and along the surface of the runway with external visual reference during final phase of landing and with a runway and runway visual range not less than 600 feet (183 m), down to 0.
<b>CCR</b>	Constant Current Regulator
<b>Cd</b>	Candela (a unit of luminous intensity)
<b>CL</b>	Center Line
<b>CTAF</b>	Common Traffic Advisory Frequency
<b>DC</b>	Direct Current
<b>DEB</b>	Direct Earth Burial
<b>Declared Distances</b>	The distances declared available and suitable for satisfying the airplane takeoff run, takeoff distance, accelerate-stop distances, and landing distance requirements. The distances are ASDA, LDA, TORA and TODA.

<b>Displaced Threshold</b>	A threshold that is located at a point on the runway other than the designated beginning of the runway.
<b>DWG</b>	Drawing
<b>E-982</b>	Steady-burning Approach Lights
<b>EMI</b>	Electromagnetic Interference
<b>EMT</b>	Electro-Mechanical Tubing
<b>FAA</b>	Federal Aviation Administration
<b>HIRL</b>	High Intensity Runway Edge Lights
<b>I/O</b>	Input/Output
<b>ICEA</b>	Insulated Cable Engineers Association
<b>IEEE</b>	Institute of Electrical and Electronics Engineers
<b>IFR</b>	Instrument Flight Rules
<b>ILS</b>	Instrument Landing System
<b>ISO</b>	International Standards Organization
<b>KV</b>	Kilovolt
<b>KVA</b>	Kilovolt Ampere
<b>KW</b>	Kilowatt
<b>L-850C</b>	Style 3 Flush in-pavement light fixture
<b>L-852D</b>	Taxiway centerline for CAT III
<b>L-852E, F</b>	Runway Guard Light in-pavement
<b>L-852G</b>	Combination Runway Guard
<b>L-852G/S</b>	Combination Runway Guard/Stop Bar Light in-pavement
<b>L-852S</b>	Stop Bar Light in-pavement
<b>L-853</b>	Reflective Markers
<b>L-854</b>	Radio Controller (Pilot Controlled Lights)
<b>L-858R, Y, L, B</b>	Guidance Signs
<b>L-860</b>	Low-Intensity Elevated Light
<b>L-861</b>	Medium-Intensity Elevated Runway/Taxiway Light

<b>L-862</b>	High-Intensity Elevated Runway Edge Light
<b>L-867</b>	Non-load Bearing Base Cans
<b>L-868</b>	Load Bearing Base Cans
<b>L-880/ L-881</b>	Precision Approach Path Indicators (PAPI)
<b>L-884</b>	Land and Hold Short Operations (LAHSO) Power Control Unit (PCU)
<b>LAHSO</b>	Land and Hold Short Operations
<b>Landing Distance Available</b>	The runway length declared available and suitable for a landing aircraft.
<b>LDA</b>	Landing Distance Available
<b>LDIN</b>	Lead-In Lighting System
<b>LHU</b>	Light Housing Unit
<b>LIRL</b>	Low Intensity Runway Edge Lights
<b>MALS</b>	Medium-intensity Approach Lighting System
<b>MALSF</b>	Medium-intensity Approach Lighting System with Sequenced Flashers
<b>MALSR</b>	Medium-intensity Approach Lighting System with Runway Alignment Indicator Lights
<b>MIRL</b>	Medium Intensity Runway Edge Lights
<b>MITL</b>	Medium Intensity Taxiway Lights
<b>MLS</b>	Microwave Landing System
<b>NAS</b>	National Airspace System
<b>NEC</b>	National Electrical Code
<b>NEMA</b>	National Electrical Manufacturers Association
<b>NFPA</b>	National Fire Protection Association
<b>Non-precision Approach Runway</b>	Runway with only horizontal guidance available
<b>Non-precision Instrument Runway</b>	A runway having an existing instrument approach procedure utilizing air navigation facilities with only horizontal guidance for which a straight-in or side-step non-precision approach procedure has been approved.
<b>NOTAM</b>	Notice To Airmen
<b>NRTL</b>	Nationally Recognized Testing Laboratory

<b>OCS</b>	Obstacle Clear Surface
<b>OFZ</b>	Obstacle Free Zone
<b>OSHA</b>	Occupational Safety and Health Administration
<b>PAPI</b>	Precision Approach Path Indicator
<b>PAR</b>	Precision Approach Radar
<b>PC</b>	Point of Curvature
<b>PCU</b>	Power and Control Unit
<b>PLC</b>	Programmable Logic Controller
<b>Precision Approach Runway</b>	Full instrument approach procedure and equipment available (ILS or MLS)
<b>Precision Instrument Runway</b>	A runway having an existing instrument approach procedure utilizing air navigation facilities with both horizontal and vertical guidance for which a precision approach procedure has been approved.
<b>PT</b>	Point of Tangency
<b>RCL</b>	Runway Centerline Lighting
<b>REIL</b>	Runway End Identifier Lights
<b>RGL</b>	Runway Guard Lights
<b>ROFA</b>	Runway Object Free Area
<b>RPZ</b>	Runway Protection Zone
<b>RSA</b>	Runway Safety Area
<b>RSAT</b>	Runway Safety Action Team
<b>Runway Environment</b>	The physical runway and the areas surrounding the runway out to the holding position marking.
<b>Runway Object Free Area</b>	An area on the ground centered on a runway provided to enhance the safety of aircraft operations by having the area free of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes.
<b>Runway Protection Zone</b>	An area off the runway end used to enhance the protection of people and property on the ground.
<b>Runway Safety Area</b>	A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or threshold.
<b>RVR</b>	Runway Visual Range

<b>SCR</b>	Silicon Controlled Rectifier
<b>SMGCS</b>	Surface Movement Guidance and Control System
<b>SPDT</b>	Single Pole Double Throw
<b>Takeoff distance available</b>	The TORA plus the length of any remaining runway and/or clearway beyond the far end of the TORA.
<b>Takeoff runway available</b>	The runway length declared available and suitable for the ground run of an airplane taking off.
<b>TDZ</b>	Touchdown Zone
<b>Threshold</b>	A line perpendicular to the runway centerline marking the beginning of the runway surface available for a landing.
<b>TODA</b>	Takeoff distance available
<b>TORA</b>	Takeoff run available
<b>UL</b>	Underwriter's Laboratory
<b>UPS</b>	Uninterruptible Power Supply
<b>VAC</b>	Voltage Alternating Current
<b>VDC</b>	Voltage Direct Current
<b>VFR</b>	Visual Flight Rules
<b>Visual Runway</b>	Runway with no instrument approach procedure/equipment
<b>VMC</b>	Visual Meteorological Conditions

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**APPENDIX 4. BIBLIOGRAPHY.**

1. AC 00-2, Federal Register, Advisory Circular Checklist and Status of Federal Aviation Regulations, updated triannually, contains the listing of all current issuances of ACs and changes thereto. It explains the circular numbering system and gives instructions for ordering ACs that are for sale as well as those distributed free of charge. AC 00-2 also gives instructions for ordering the Federal Aviation Regulations.

- a. FAA ACs. Copies of the current edition of the AC may be obtained at no charge from the FAA Website at: [www.faa.gov](http://www.faa.gov).

Department of Transportation  
General Services Paragraph M443.2  
Washington, DC 20590

- (1) AC 70/7460-1, *Obstruction Marking and Lighting*.
    - (2) AC 120-28, *Criteria for Approval of Category III Landing Weather Minima for Takeoff, Landing, and Rollout*.
    - (3) AC 120-29, *Criteria for Approval of Category I and Category II Landing Minima for Approach*.
    - (4) AC 120-57, *Surface Movement Guidance and Control System (SMGCS)*.
    - (5) AC 150/5000-3, *Address List for Regional Airports Divisions and Airports District Offices*.
    - (6) AC 150/5000-13, *Announcement of Availability--RTCA Inc., Document RTCA-221*.
    - (7) AC 150/5200-30, *Airport Winter Safety and Operations*.
    - (8) AC 150/5300-13, *Airport Design*.
    - (9) AC 150/5340-1, *Standards for Airport Markings*.
    - (10) AC 150/5340-26, *Maintenance of Airport Visual Aid Facilities*.
    - (11) AC 150/5345-3, *Specification for L-821 Panels for Control of Airport Lighting*.
    - (12) AC 150/5345-5, *Circuit Selector Switch*.
    - (13) AC 150/5345-7, *Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits*.
    - (14) AC 150/5345-10, *Specification for Constant Current Regulators and Regulator Monitors*.
    - (15) AC 150/5345-12, *Specification for Airport and Heliport Beacons*.
    - (16) AC 150/5345-13, *Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits*.
    - (17) AC 150/5345-26, *Specification for L-823 Plug and Receptacle, Cable Connectors*.
    - (18) AC 150/5345-27, *Specification for Wind Cone Assemblies*.

- (19) AC 150/5345-28, *Precision Approach Path Indicator (PAPI) Systems*.
- (20) AC 150/5345-39, *FAA Specification L-853, Runway and Taxiway Retroreflective Markers*.
- (21) AC 150/5345-42, *FAA Specification L-867, L-868, Airport Light Bases, Transformer Housing, Junction Boxes, and Accessories*.
- (22) AC 150/5345-43, *Specification for Obstruction Lighting Equipment*.
- (23) AC 150/5345-46, *Specification for Runway and Taxiway Light Fixtures*.
- (24) AC 150/5345-47, *Specification for Series to Series Isolation Transformers for Airport Lighting Systems*.
- (25) AC 150/5345-49, *Specification L-854, Radio Control Equipment*.
- (26) AC 150/5345-50, *Specification for Portable Runway Lights*.
- (27) AC 150/5345-51, *Specification for Discharge-Type Flasher Equipment*.
- (28) AC 150/5345-53, *Airport Lighting Equipment Certification Program*.
- (29) AC 150/5345-54, *Specification for L-884 Power and Control Unit for Land and Hold Short Lighting Systems*.
- (30) AC 150/5345-56, *Specification for L-890 Airport Lighting Control and Monitoring Systems (ALCMs)*.
- (31) AC 150/5370-2, *Operational Safety on Airports During Construction*.
- (32) AC 150/5370-10, *Standards for Specifying Construction of Airports*.
- b. Electronic copies of FAA Standards may be obtained from: <https://dmrs.faa.gov> .
  - (1) FAA Order 7110.118, *Land and Hold Short Operations (LAHSO)*.
  - (2) FAA Order 6030.20A, *Electrical Power Policy*.
  - (3) FAA Order 6850.2, *Visual Guidance Lighting Systems*.
  - (4) FAA Order 6950.11, *Reduced Electrical Power Interruptions at FAA Facilities*.
  - (5) FAA Order 6950.27, *Short Circuit Analysis and Protective Device Case Study*.
- c. FAA drawings may be obtained from:  

FAA William J. Hughes Technical Center  
NAS Documentation Facility, ACK-1  
Atlantic City International Airport  
New Jersey, 08405

  - (1) FAA DWG C-6046, *Frangible Coupling Type I and Type IA, Details*.
  - (2) Engineering Brief #61, *Installation Procedures for Adjustable Light Bases and Extensions*.

- (3) FAA-C-1391, *Installation and Splicing of Underground Cable*.
  - (4) FAA-E-2083, *Bypass Switch, Engine Generator*.
  - (5) FAA-E-2204, *Diesel Engine Generator Sets, 10kw to 750kw*.
  - (6) FAA-E-2325, *Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights*.
  - (7) 14 CFR part 77, *Objects Affecting Navigable Airspace*.
  - (8) 14 CFR part 139, *Certifications and Operations; Land Airports Serving Certain Air Carriers*.
- d. Electronic copy of the Aeronautical Information Manual (AIM) may be obtained from: [www.faa.gov](http://www.faa.gov).
2. **Federal Specifications.** Copies of Federal specifications may be obtained at no charge from: General Services Administration Offices in Washington, DC, and other cities. For access to Federal Specifications go to: <http://apps.fss.gsa.gov/pub/fedspecs>.
- U.S. General Services Administration  
1800 F Street, NW  
Washington, DC 20405
- a. Federal Specification J-C-145, *Cable, Power, Electrical and Wire, Electrical (Weather-Resistant)*.
  - b. Federal Specification TT-P-28, *Paint, Aluminum, Heat Resisting (1200 Deg. F.)*.
  - c. FED-STD-595, *Colors Used in Government Procurement*.
3. **American Society for Testing and Materials (ASTM) Specifications, Test Methods, Standard Practices, and Recommended Practices.** Copies of ASTM specifications, test methods, and recommended practices may be obtained from: American Society for Testing and Materials. Contact them at: [www.astm.org](http://www.astm.org)
- American Society for Testing and Materials  
1916 Race Street  
Philadelphia, PA 19103
- a. ASTM C-892, *Standard Specification for High Temperature Fiber Blanket Thermal Insulation*.
  - b. ASTM D-3407, *Standard Test Method for Joint Sealants, Hot Poured, for Concrete and Asphalt Pavements*.
  - c. ASTM A-53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless*.
  - d. ASTM-A184, *Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement*.
  - e. ASTM-A704, *Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement*.

4. **National Fire Protection Association (NFPA):** Copies of the National Electrical Code (NFPA 70) can be obtained: [www.nfpa.org](http://www.nfpa.org).

NFPA  
1 Batterymarch Park  
Quincy, Massachusetts  
USA 02169-7471

5. **American National Standards Institute (ANSI).** Copies of ANSI standards may be obtained from the National Standards Institute. Contact them at: [www.ansi.org](http://www.ansi.org)

ANSI  
1819 L Street, NW, 6th floor  
Washington, DC 20036

- a. ANSI/ICEA S-85-625, *Telecommunications Cable Air Core, Polyolefin Insulated, Copper Conductor, Technical Requirements*.

## **APPENDIX 5. TYPICAL INSTALLATION DRAWINGS FOR AIRPORT LIGHTING EQUIPMENT.**

The following drawings depict typical installation methods for various types of airport lighting equipment and are acceptable for use on projects funded under the AIP. However, the drawings may need to be revised to accommodate local site conditions and/or special requirements.

Figures are typical non-proprietary equipment. Other equipment, such as adjustable cans, is acceptable. Details of equipment and installation methods will be provided by manufacturers.

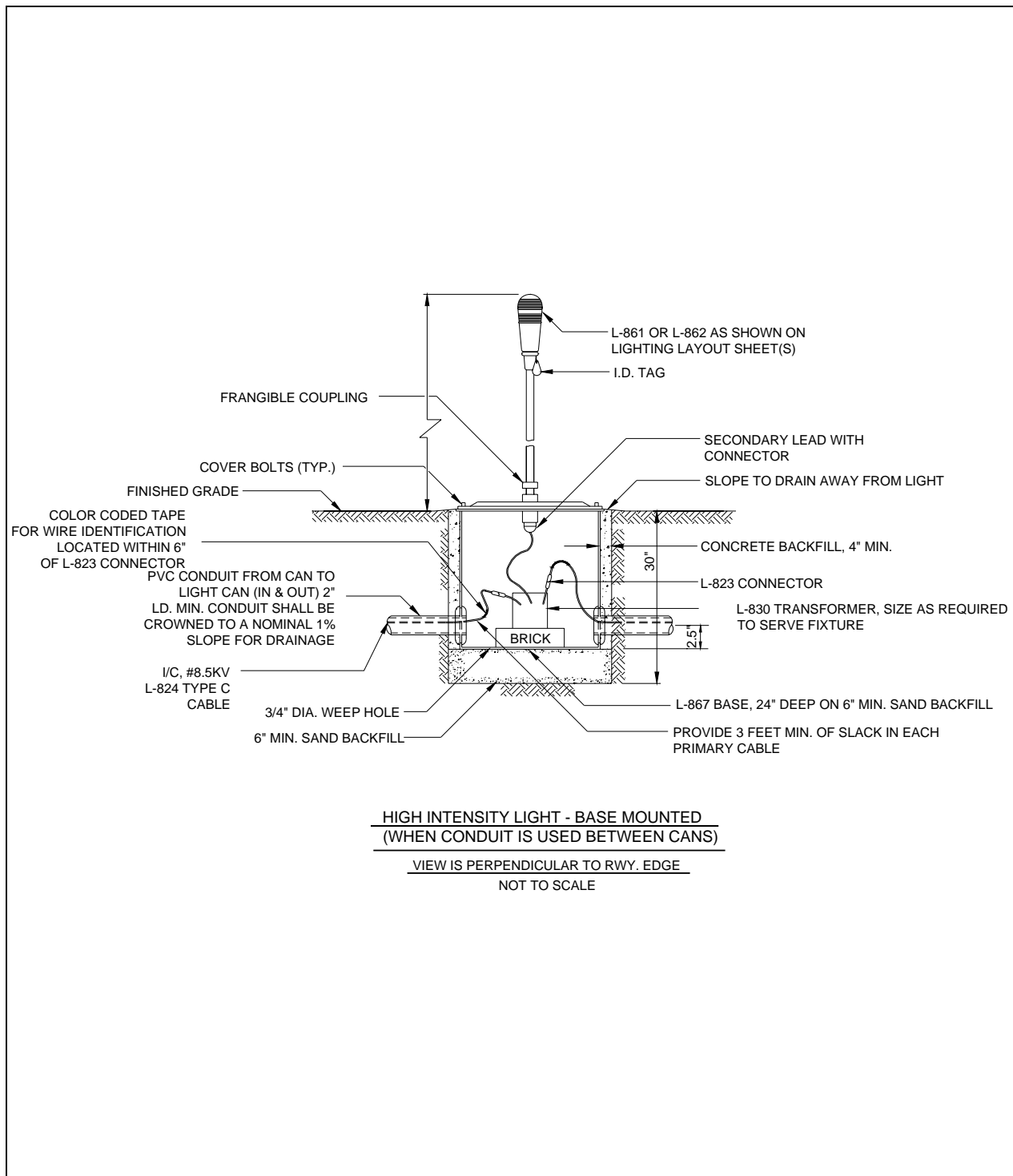


Figure 112. Typical Standard Details for Runway & Taxiway Edge Lights –High Intensity Light – Non-adjustable Base-mounted.

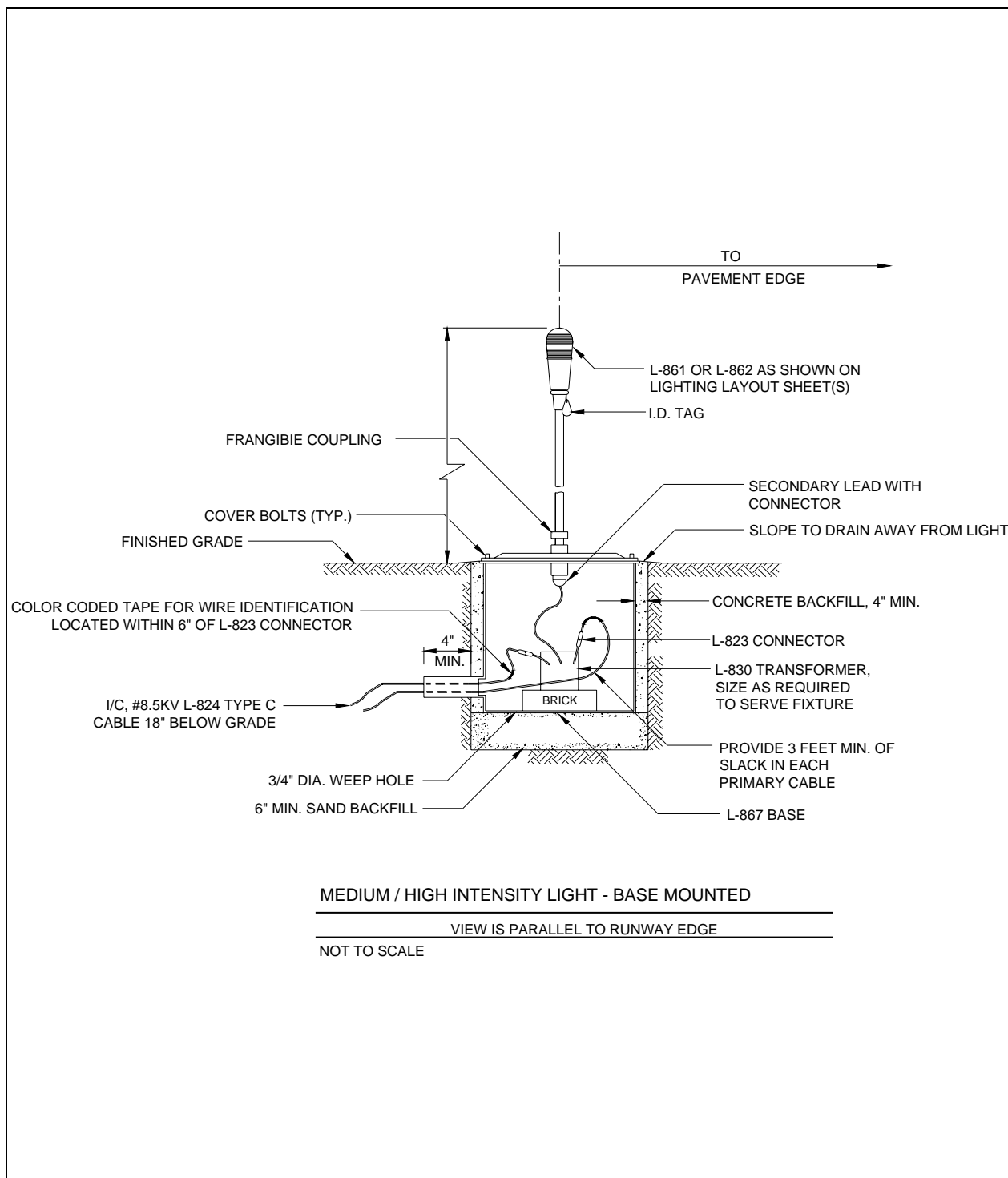


Figure 113. Typical Standard Details for Runway & Taxiway Edge Lights –Medium / High Intensity Light – Non-adjustable Base-mounted.

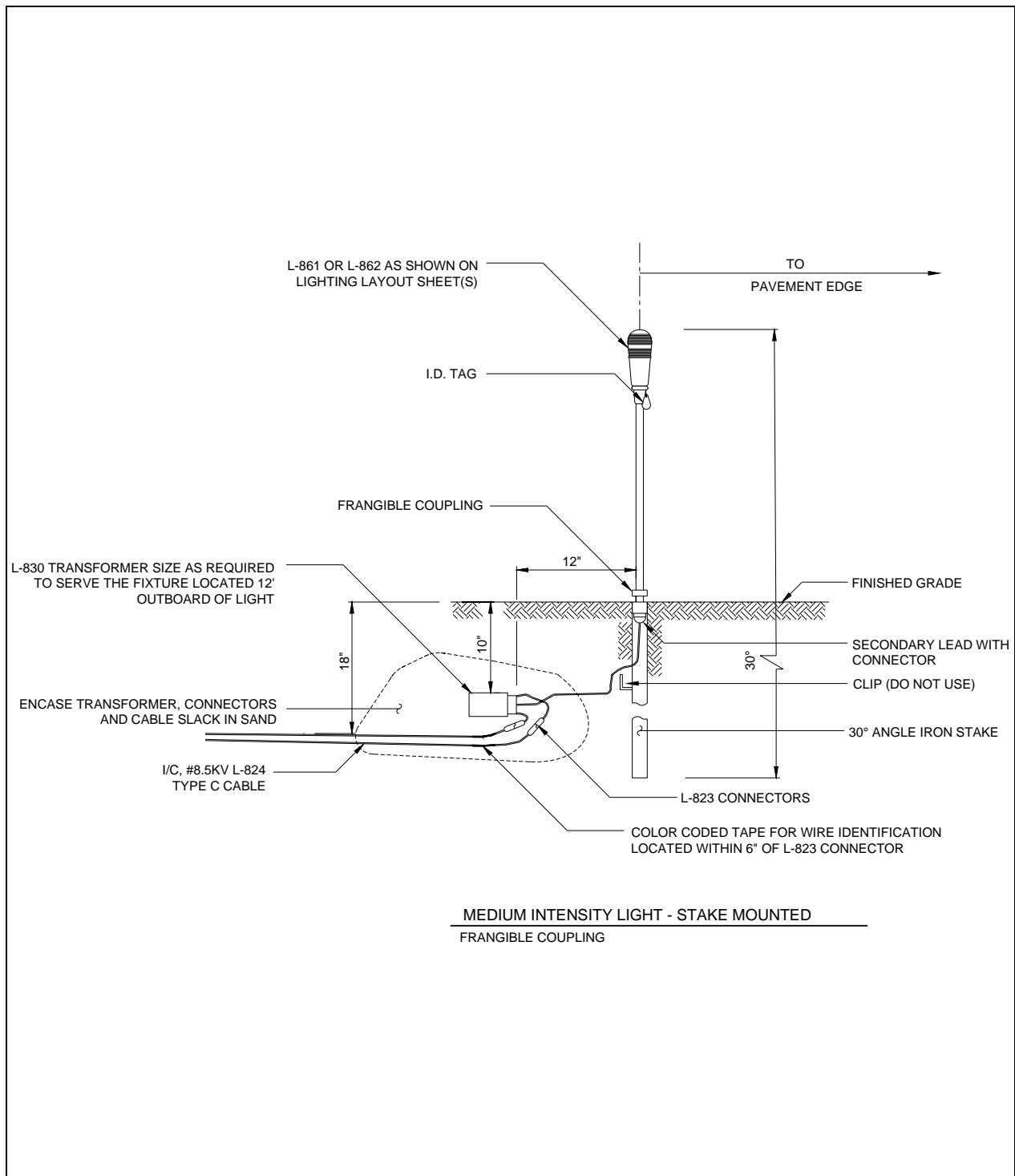


Figure 114. Typical Standard Details for Runway & Taxiway Edge Lights –Medium Intensity Light – Stake-mounted.



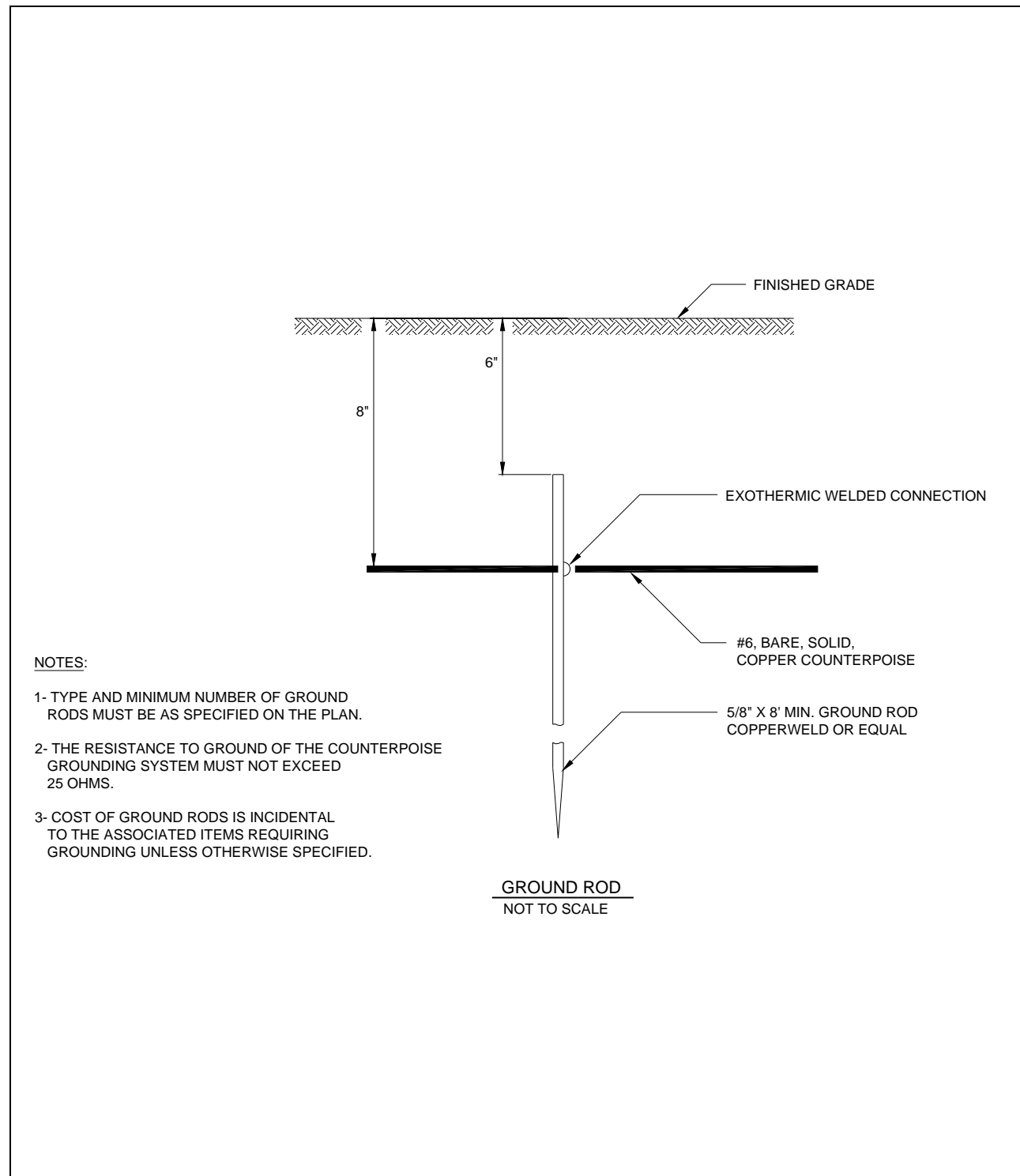
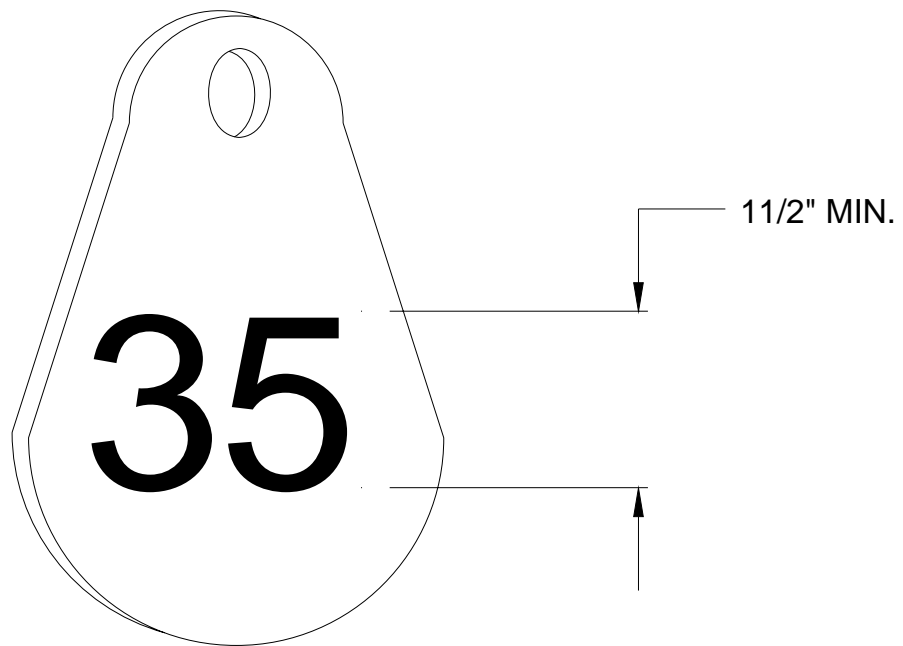


Figure 115. Typical Standard Details for Runway and Taxiway Edge Lights –Ground Rod.



NOTE:

AFFIX NON-CORROSIVE TAG TO FIXTURE  
FACING RUNWAY WITH SET SCREW, WIRE  
TIE, OR METAL BAND. NUMERALS  
MUST BE ENGRAVED FOR PERMANENT  
READABILITY.

TAG DETAIL  
NOT TO SCALE

Figure 116. Identification (ID) Tag Detail.

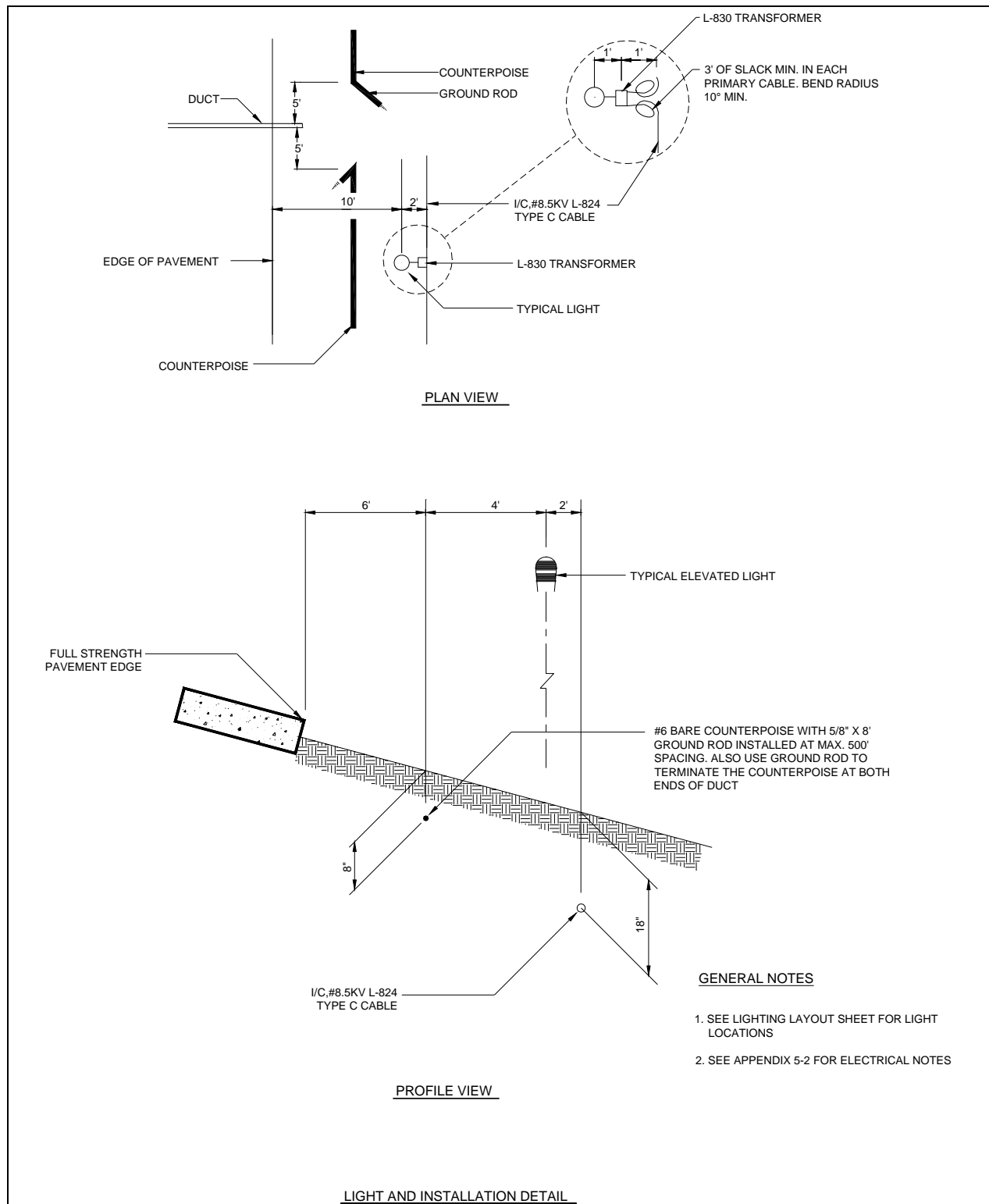
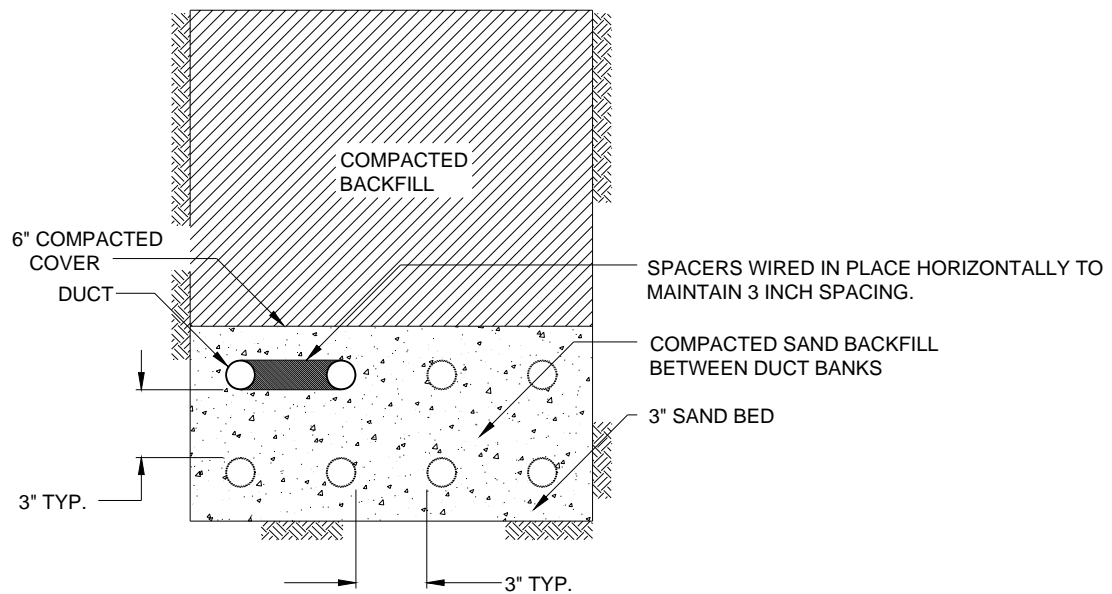


Figure 117. Typical Standard Details for Runway and Taxiway Edge Lights – Light &amp; Installation Detail.



TYPICAL MULTIPLE BANK LAYOUT

NOTES:

- 1- DUCTS MUST BE CROWNED TO A NORMAL 1% SLOPE FOR DRAINAGE.
- 2- DUCTS ARE 3" UNLESS OTHERWISE SPECIFIED
- 3- NUMBER OF BANKS AND CONFIGURATION AS SPECIFIED ON THE PLANS.

Figure 118. Standard Details for Underground Cable Installation – Typical Multiple Bank Layout.

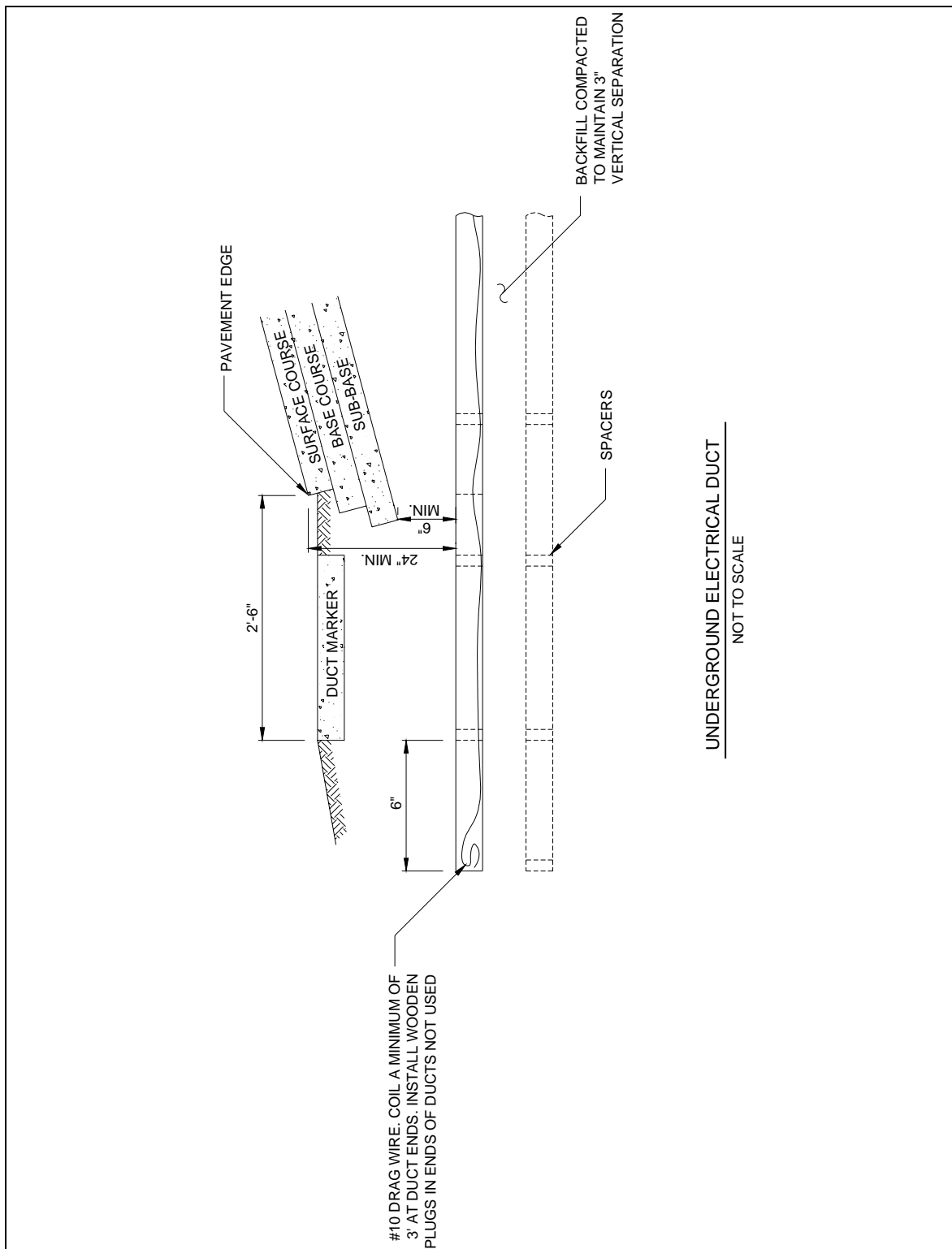
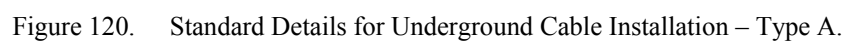


Figure 119. Standard Details for Underground Cable Installation – Underground Electrical Duct.



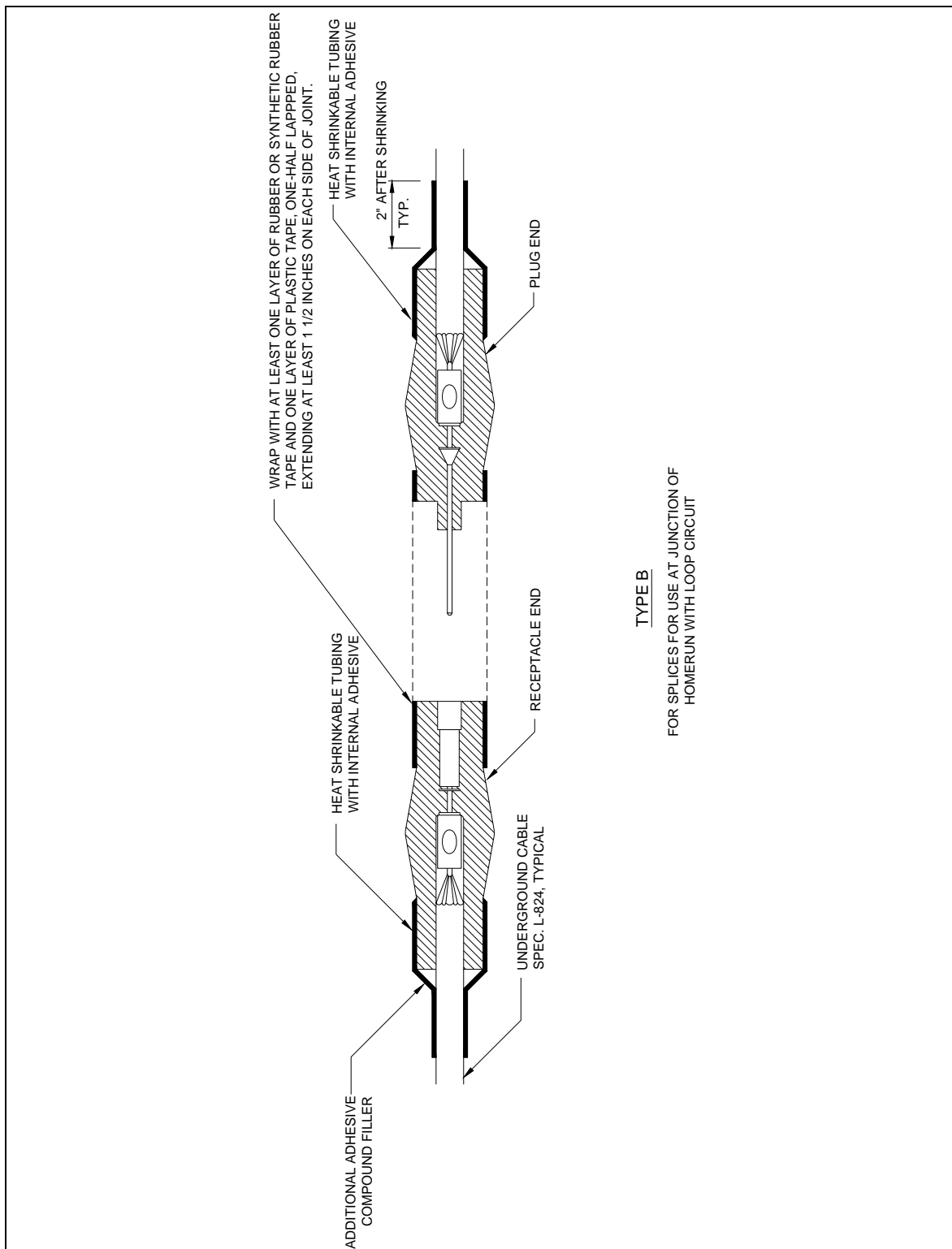


Figure 121. Standard Details for Underground Cable Installation – Type B.

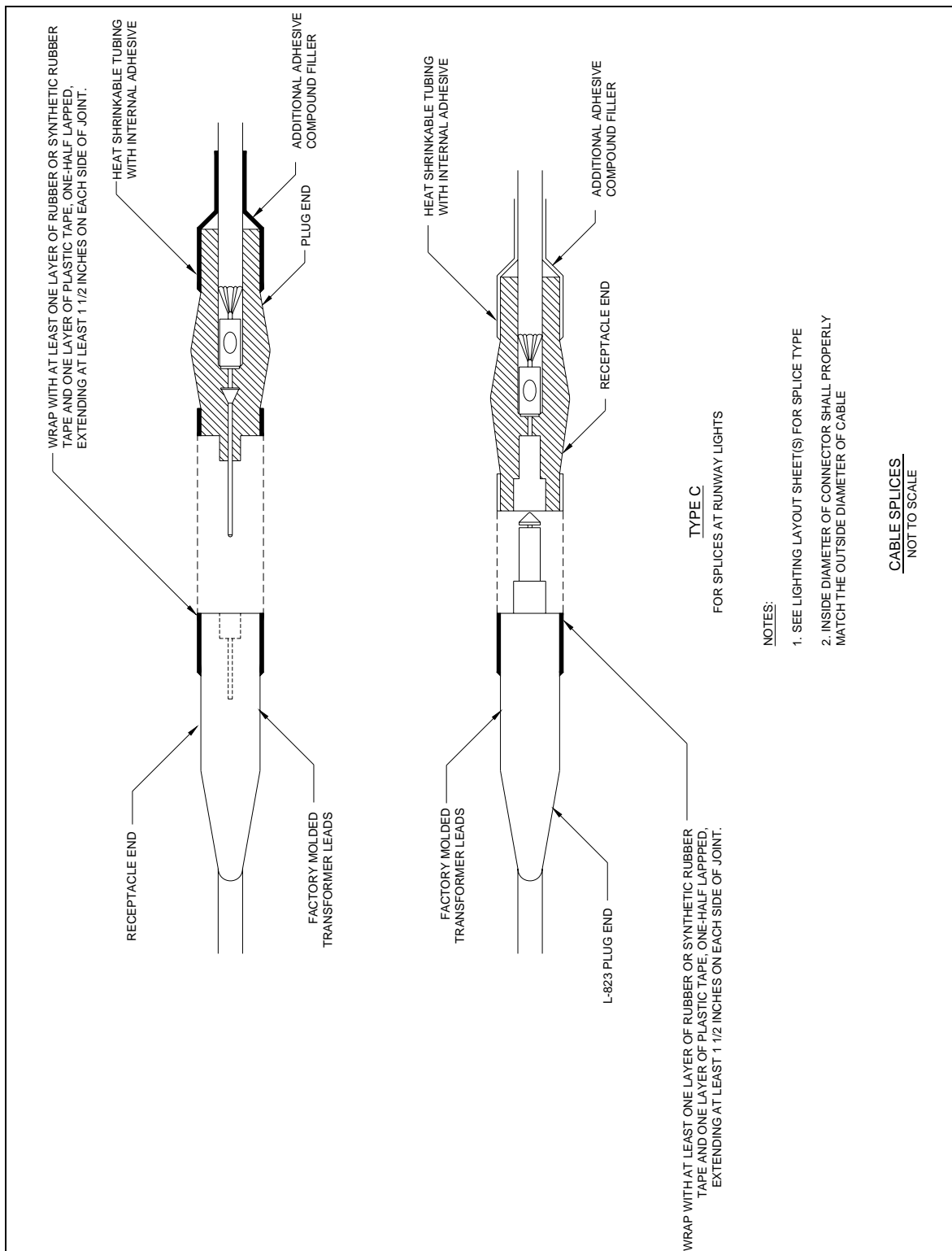


Figure 122. Standard Details for Underground Cable Installation – Type C.



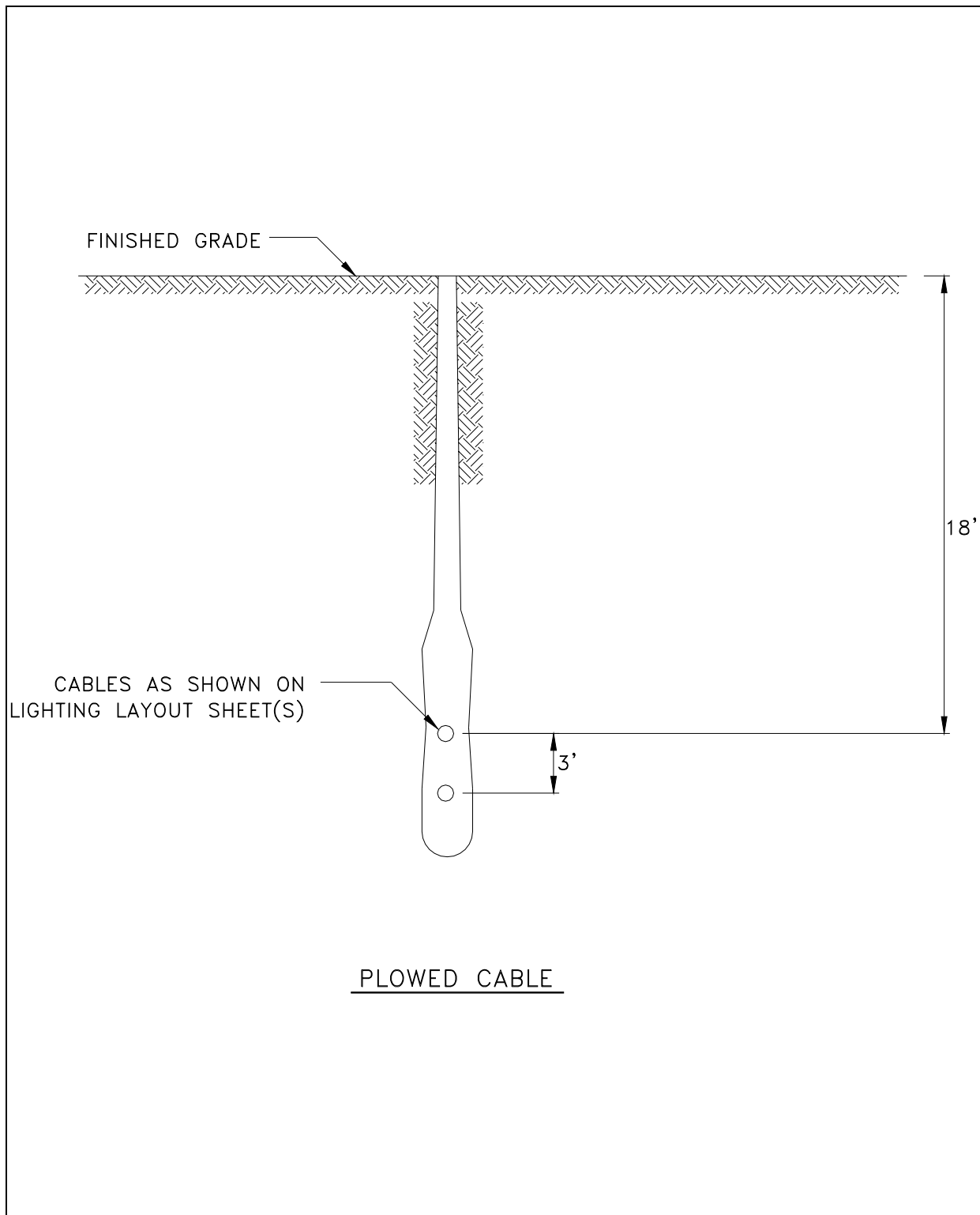


Figure 123. Standard Details for Underground Cable Installation – Plowed Cable.

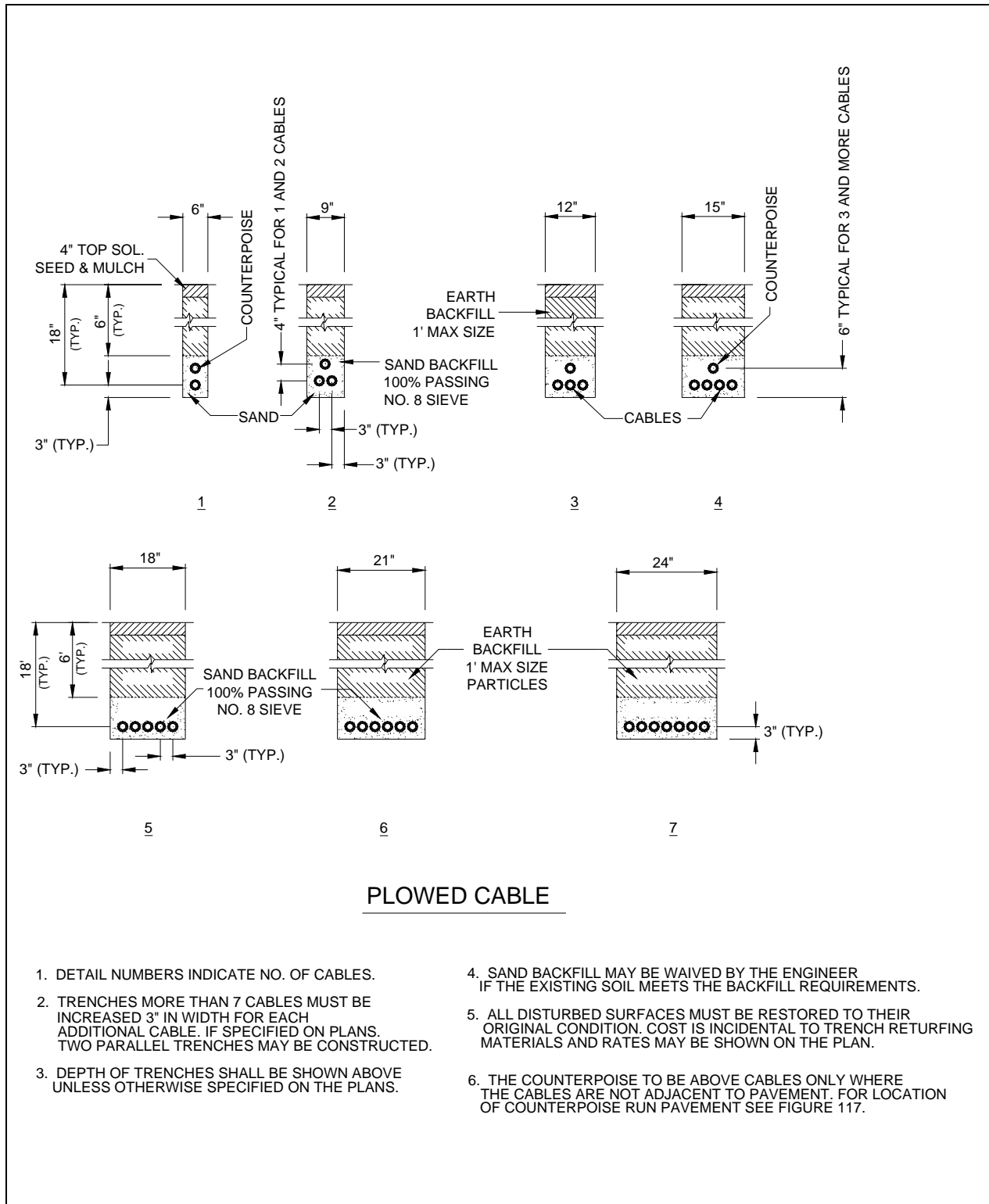


Figure 124. Standard Details for Underground Cable Installation – Plowed Cable.

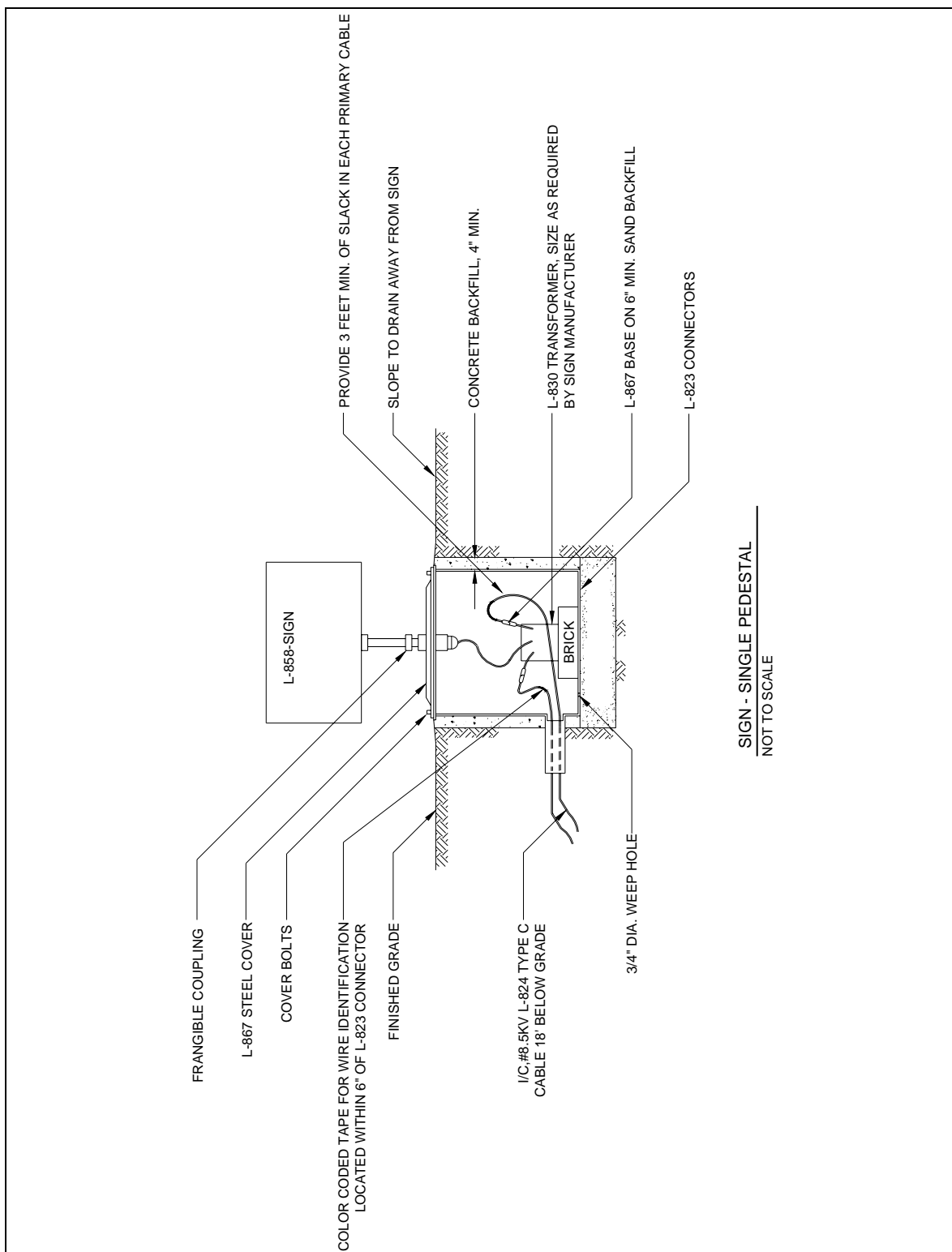
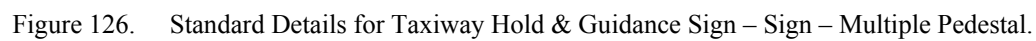


Figure 125. Standard Details for Taxiway Hold and Guidance Sign – Sign – Single Pedestal.



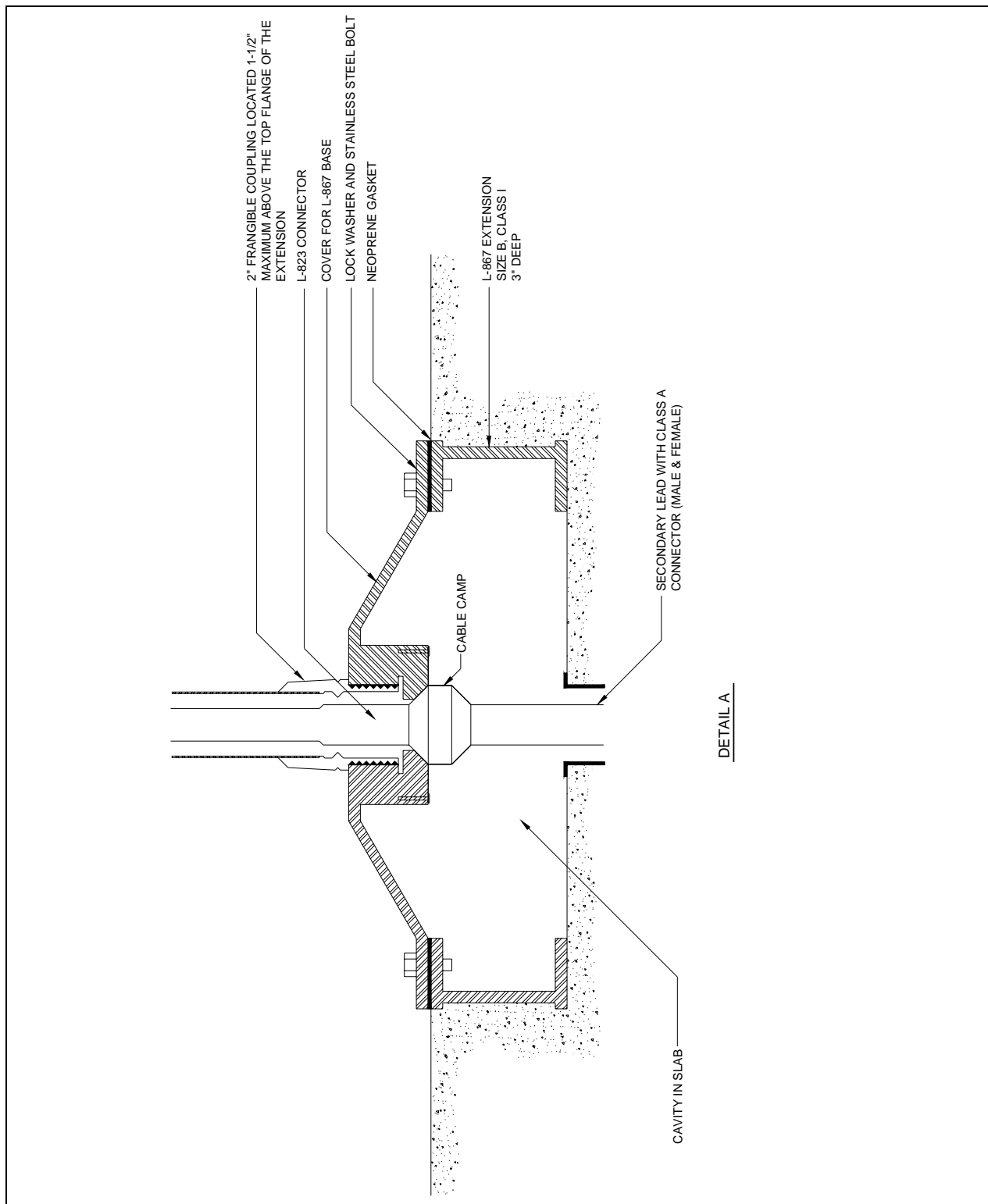


Figure 127. Standard Details for Taxiway Hold &amp; Guidance Sign – Detail A.

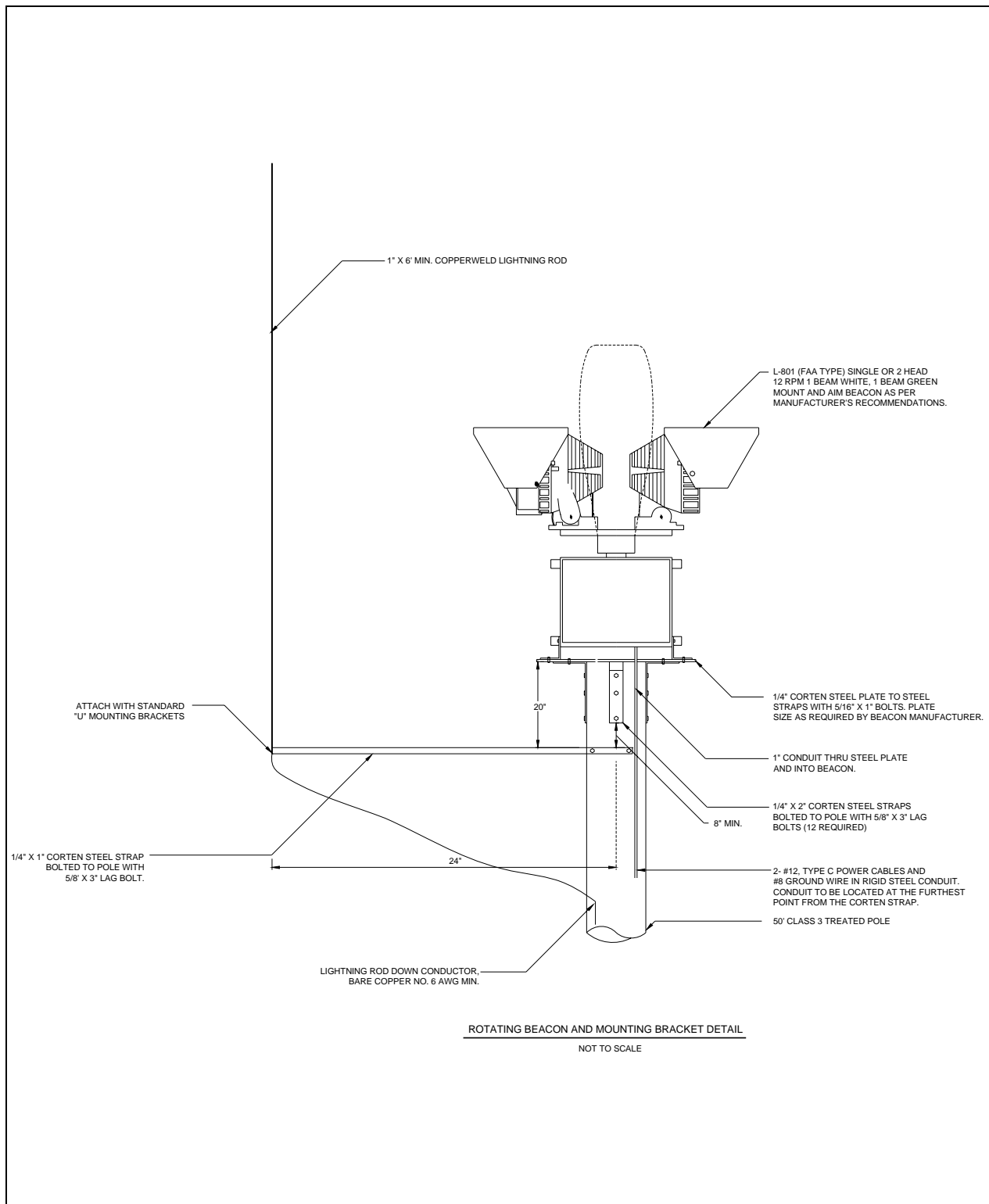


Figure 128. Standard Details for Pivoting Rotating Beacon Pole – Rotating Beacon & Mounting Bracket Detail.

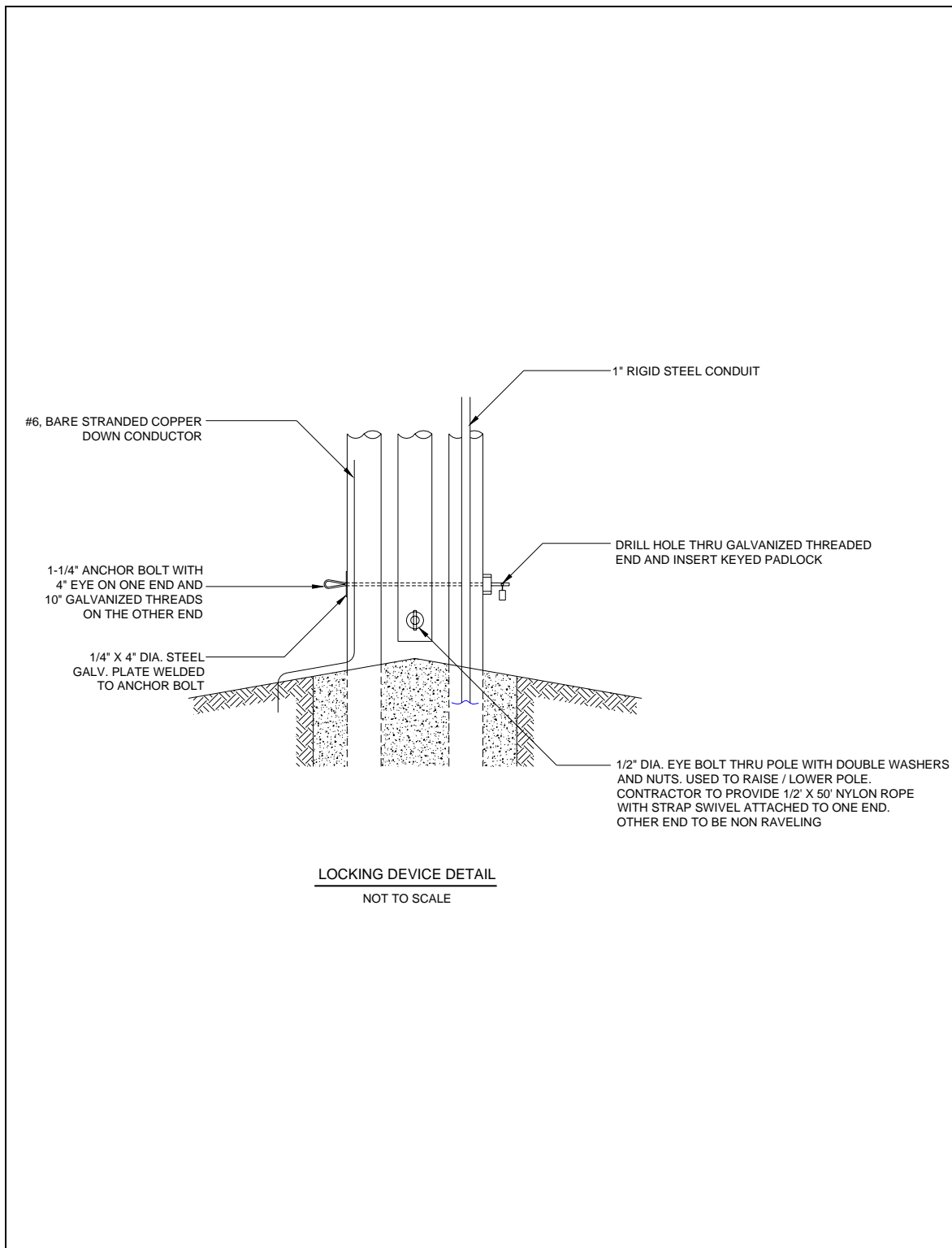


Figure 129. Standard Details for Pivoting Rotating Beacon Pole – Locking Device Detail.

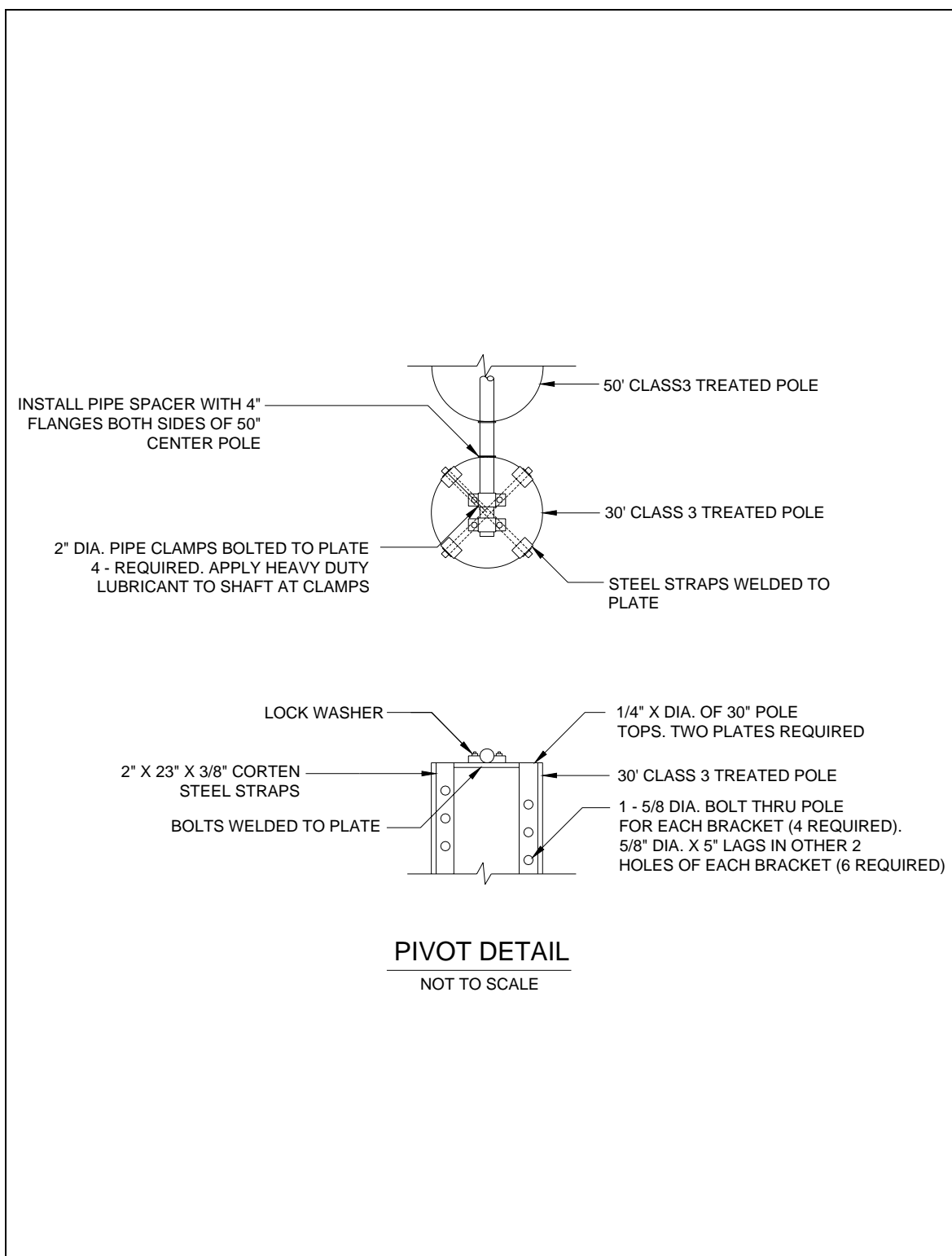


Figure 130. Standard Details for Pivoting Rotating Beacon Pole – Pivot Detail.



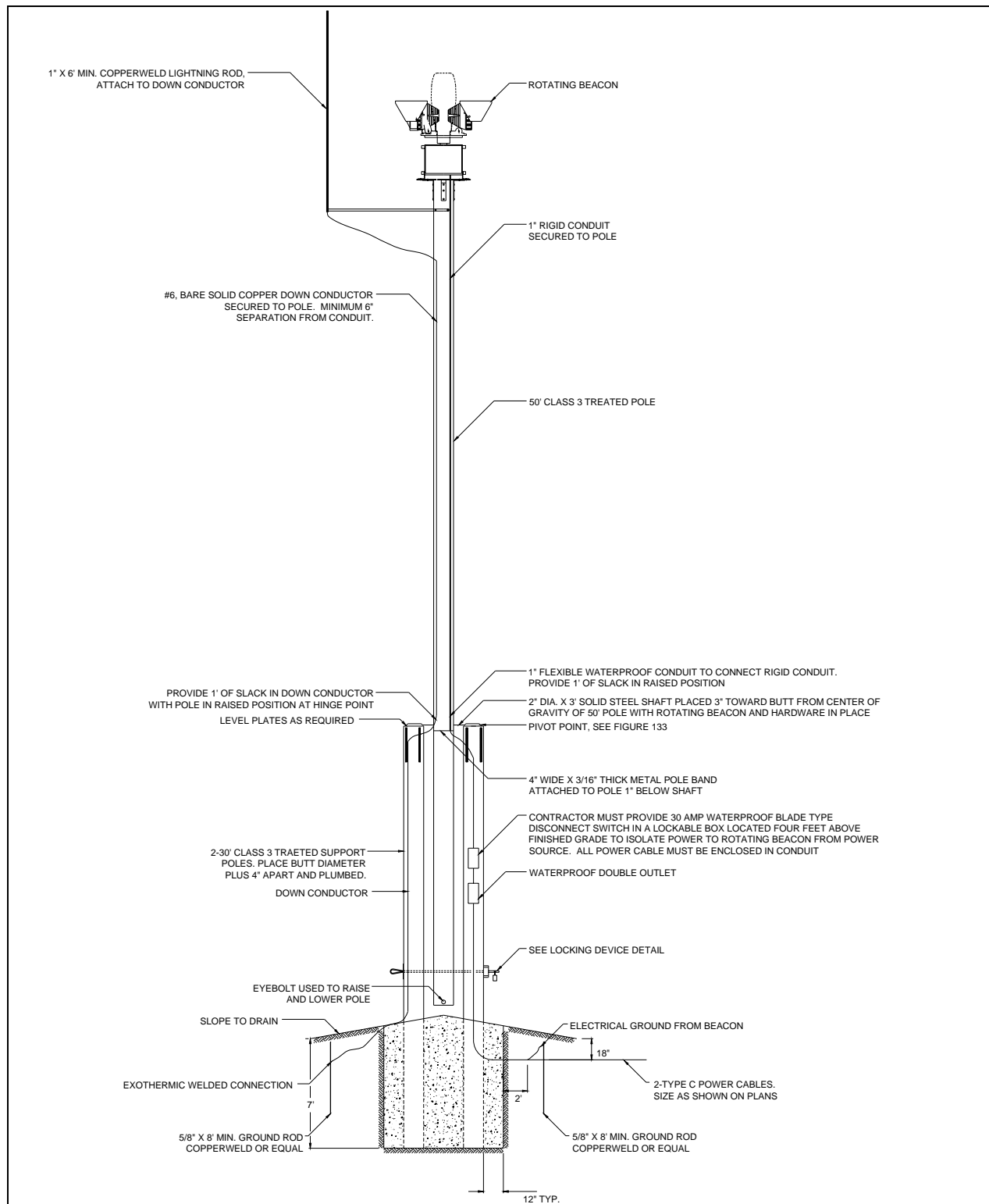


Figure 131. Standard Details for Pivoting Rotating Beacon Pole.

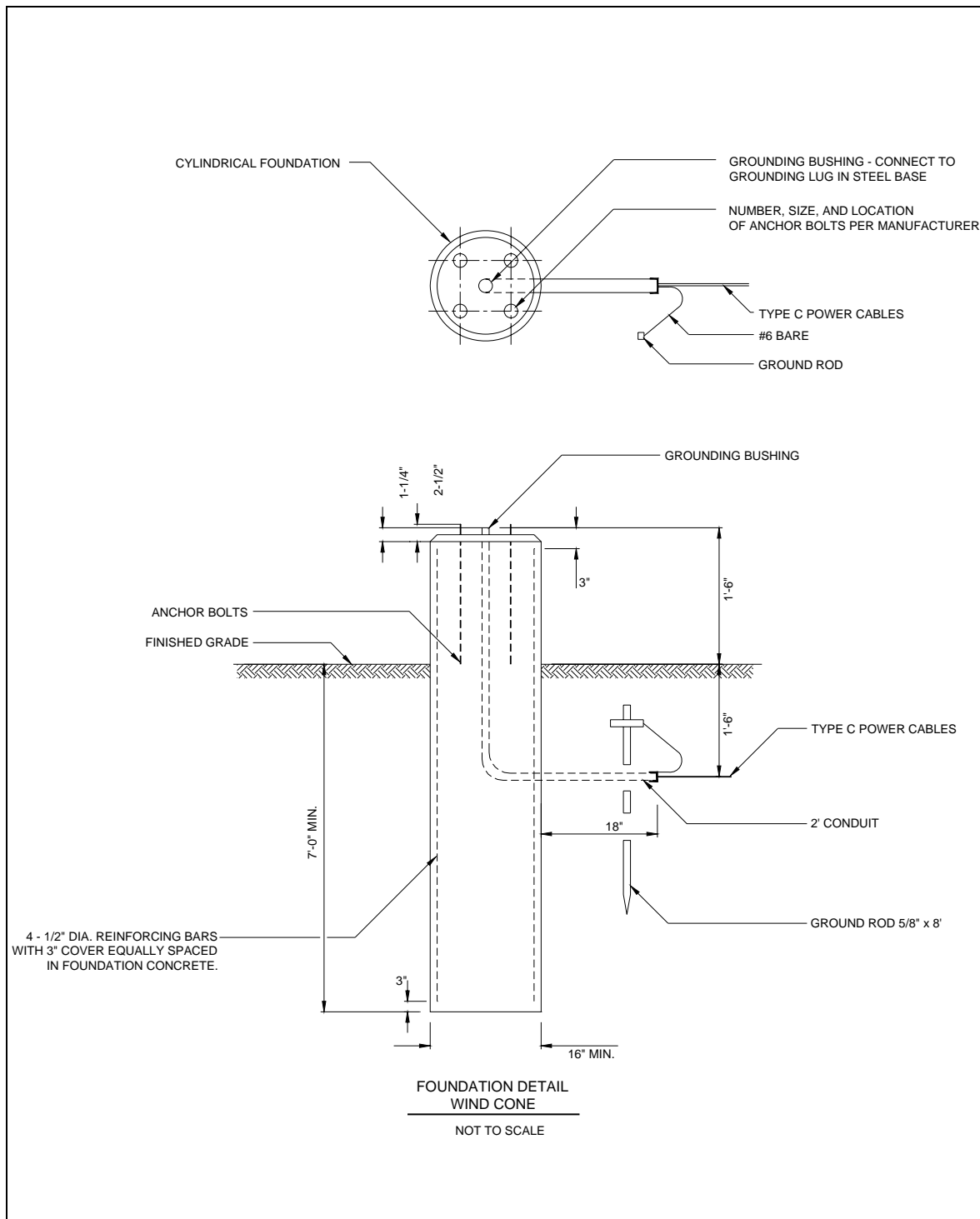


Figure 132. Standard Details for Wind Cone Foundation (L-807).

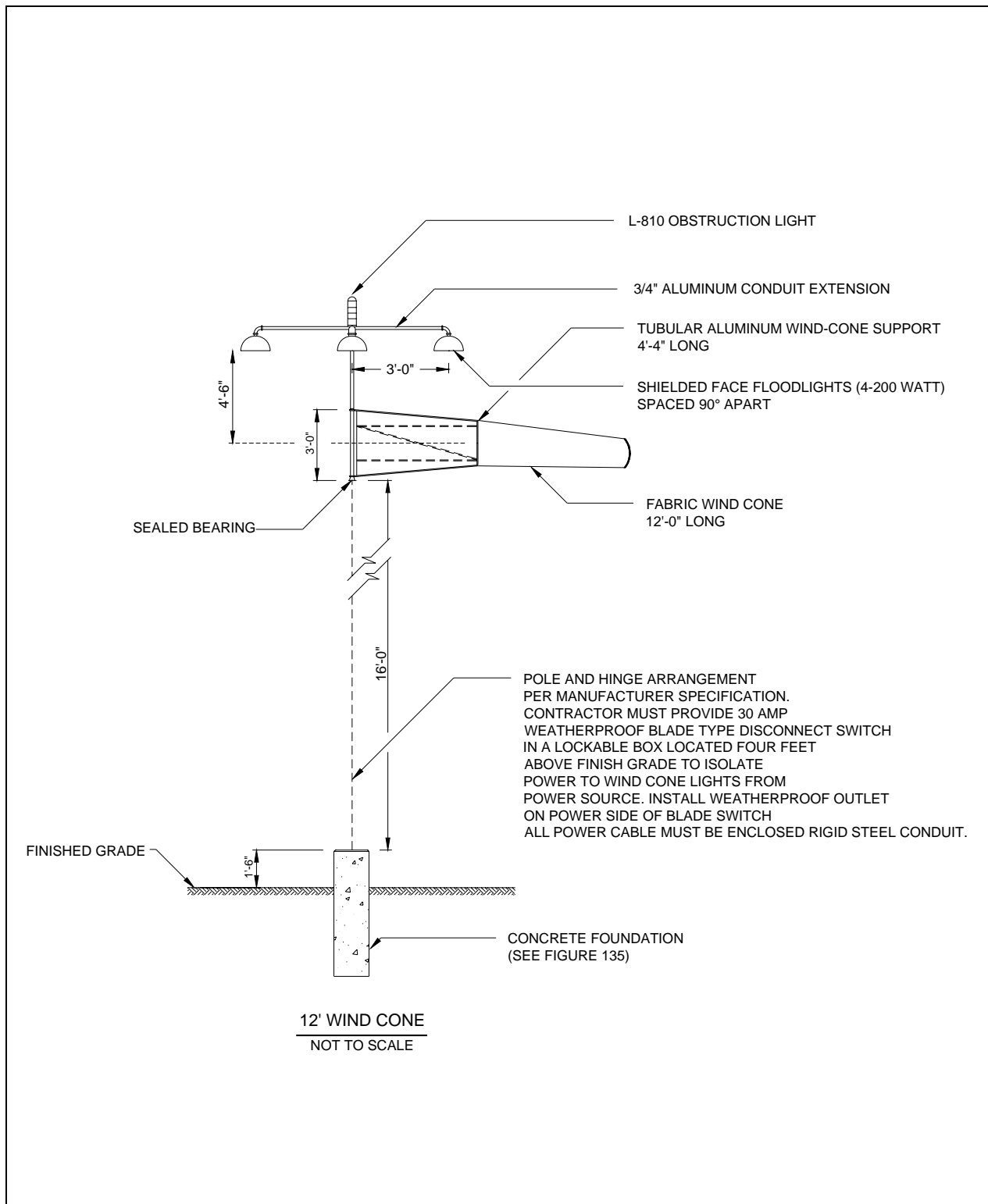


Figure 133. Standard Details for Wind Cone – 12 ft (3.7 m) Wind Cone.

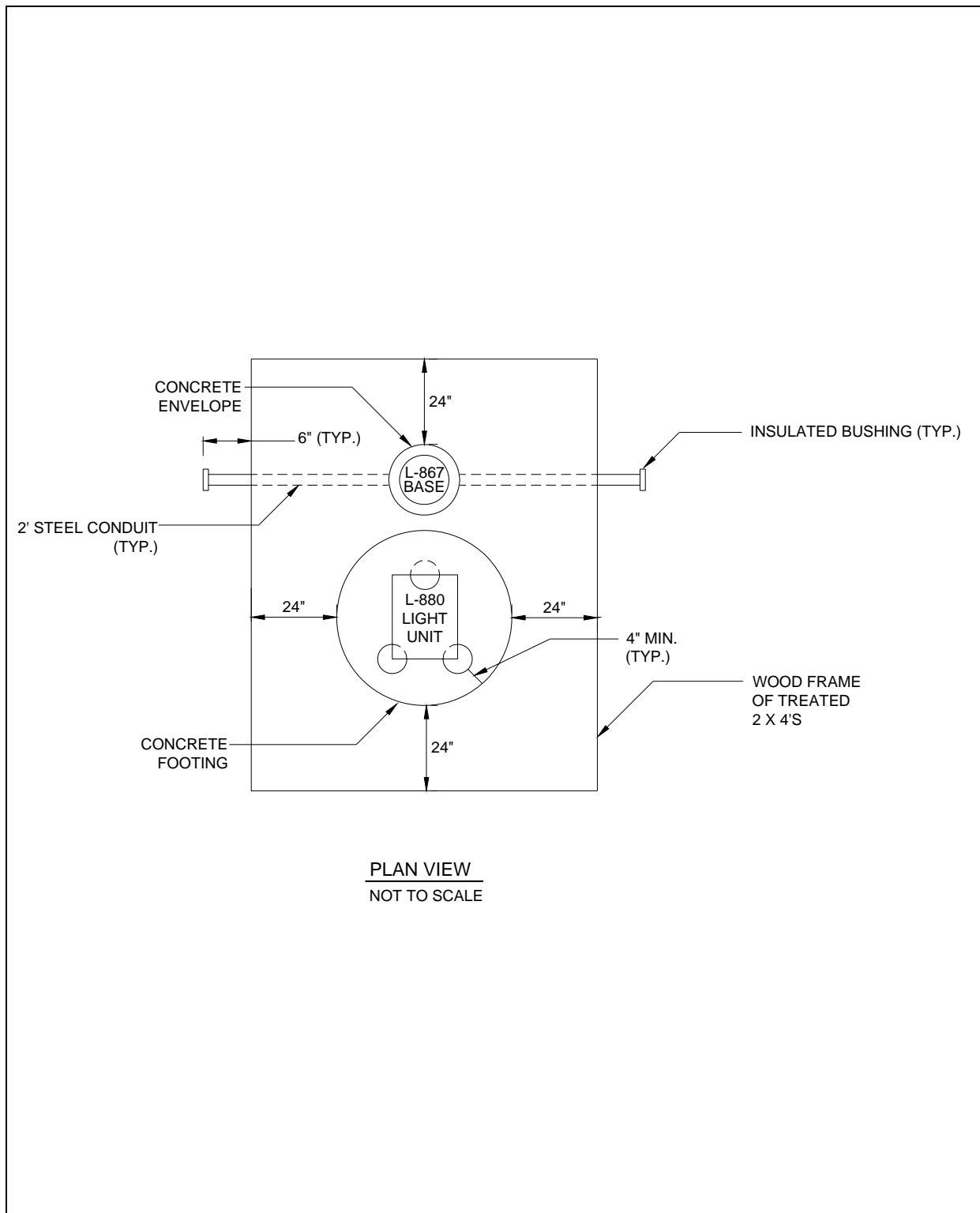


Figure 134. Standard Details for Precision Approach Path Indicators (PAPIs) – Plan View.

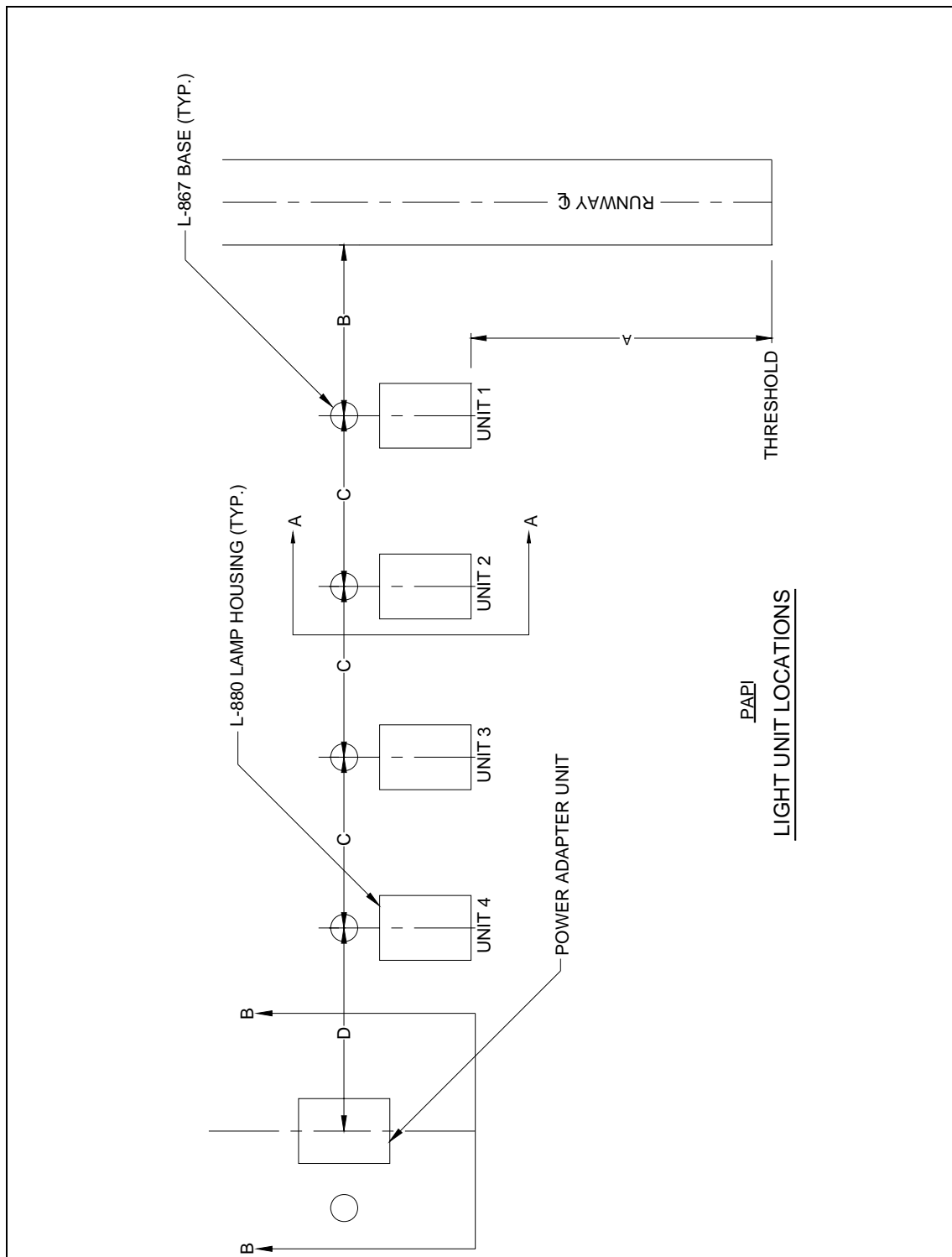


Figure 135. Standard Details for Precision Approach Path Indicators (PAPIs) – PAPI Light Unit Locations.

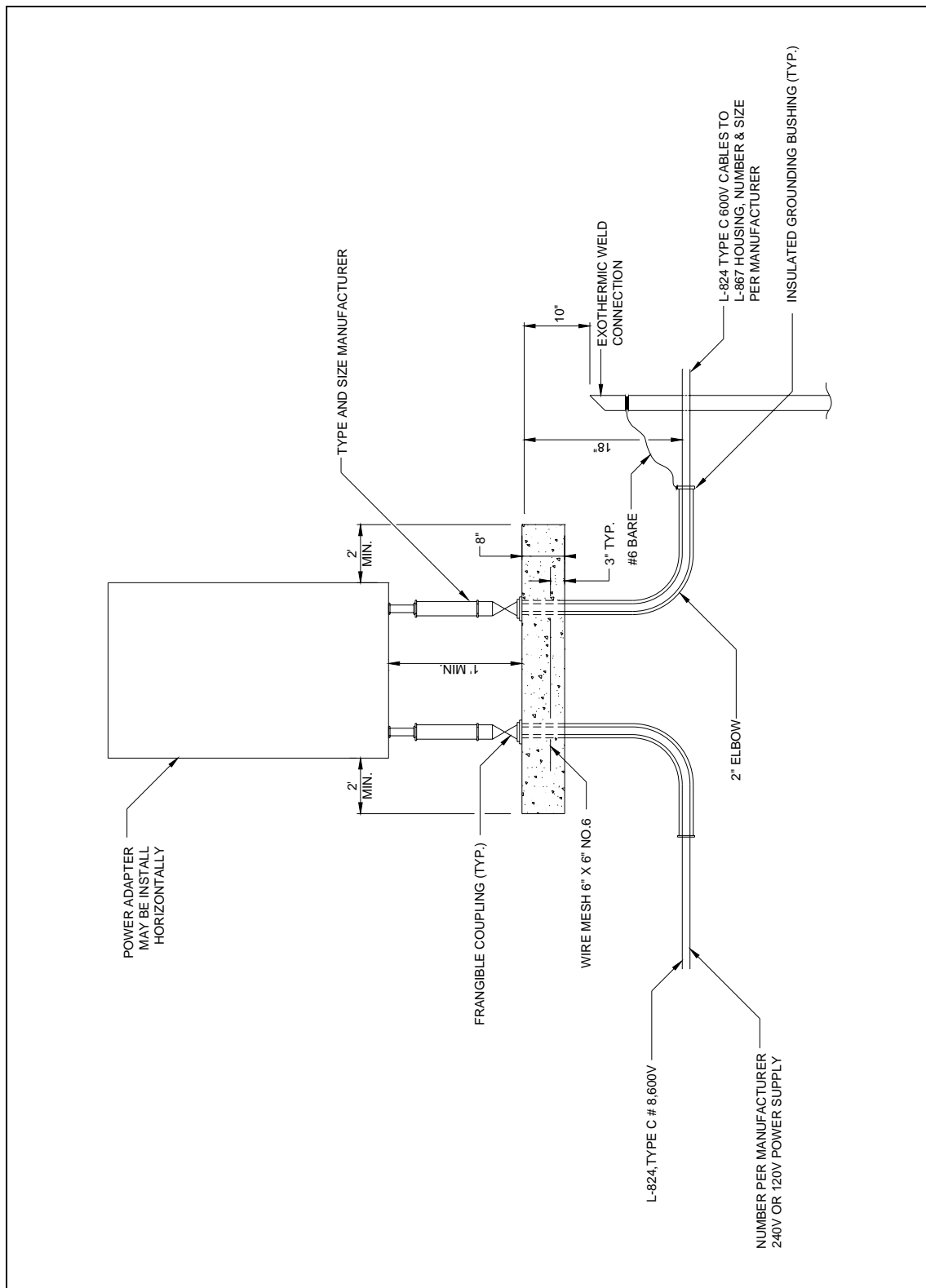


Figure 136. Standard Details for Precision Approach Path Indicators (PAPIs).

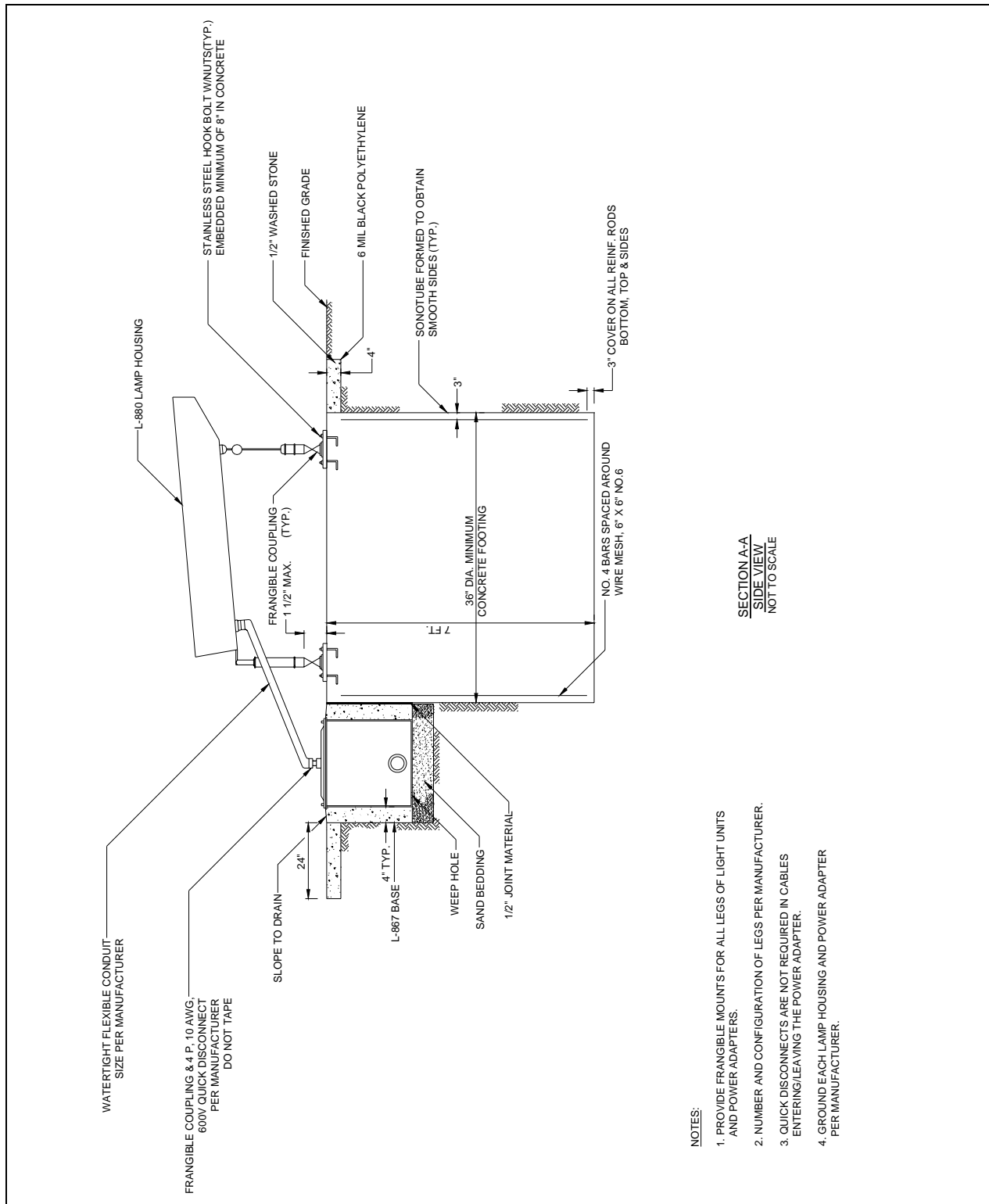


Figure 137. Standard Details for Precision Approach Path Indicators (PAPIs) – Section A-A.

DESCRIPTION	RUNWAY END	RUNWAY END	RUNWAY END	RUNWAY END
DIMENSION A				
DIMENSION B				
DIMENSION B				
DIMENSION C				
DIMENSION D				
THRESHOLD ELEVATION				
APERTURE ELEVATION UNIT 1				
APERTURE ELEVATION UNIT 2				
APERTURE ELEVATION UNIT 3				
APERTURE ELEVATION UNIT 4				
AIMING ANGLE UNIT 1				
AIMING ANGLE UNIT 2				
AIMING ANGLE UNIT 3				
AIMING ANGLE UNIT 4				

BASE DESIGN & LAYOUT IN CHAPTER 4

GENERAL NOTES:

1. APPLY "NEVER SEEZ" OR APPROVED EQUAL TO ALL THREADED BOLTS AND CONNECTIONS.
2. AZIMUTHAL AIMING. EACH LIGHT UNIT MUST BE AIMED OUTWARD INTO APPROACH ZONE ON A LINE PARALLEL TO THE RUNWAY CENTERLINE WITHIN A TOLERANCE OF  $\pm 1/2$  DEGREE.
3. MOUNTING HEIGHT TOLERANCES. THE BEAM CENTERS OF ALL LIGHT UNITS MUST BE WITHIN 1 INCH OF A HORIZONTAL PLANE, THIS HORIZONTAL PLANE MUST BE WITHIN  $\pm 1$  FOOT (0.3M) OF THE ELEVATION OF THE RUNWAY CENTERLINE AT THE INTERCEPT POINT OF THE VISUAL GLIDEPATH WITH THE RUNWAY EXCEPT AT LOCATIONS WHERE THE LIGHT UNITS ARE RAISED TO CLEAR SNOW.
4. TOLERANCE ALONG LINE PERPENDICULAR TO RUNWAY. THE FRONT FACE OF EACH LIGHT UNIT IN A BAR MUST BE LOCATED ON A LINE PERPENDICULAR TO THE RUNWAY CENTERLINE WITHIN  $\pm 6$  INCHES.
5. THE POWER & CONTROL UNIT MUST BE STYLE A, CLASS II.
6. SEE APPENDIX 5-2, SHEETS 8 THROUGH 10, FOR ELECTRICAL NOTES.
7. THE DIFFERENCE IN LATERAL SPACING BETWEEN THE LIGHT UNITS MUST NOT EXCEED ONE FOOT.

Figure 138. Precision Approach Path Indicators (PAPIs) Chart.



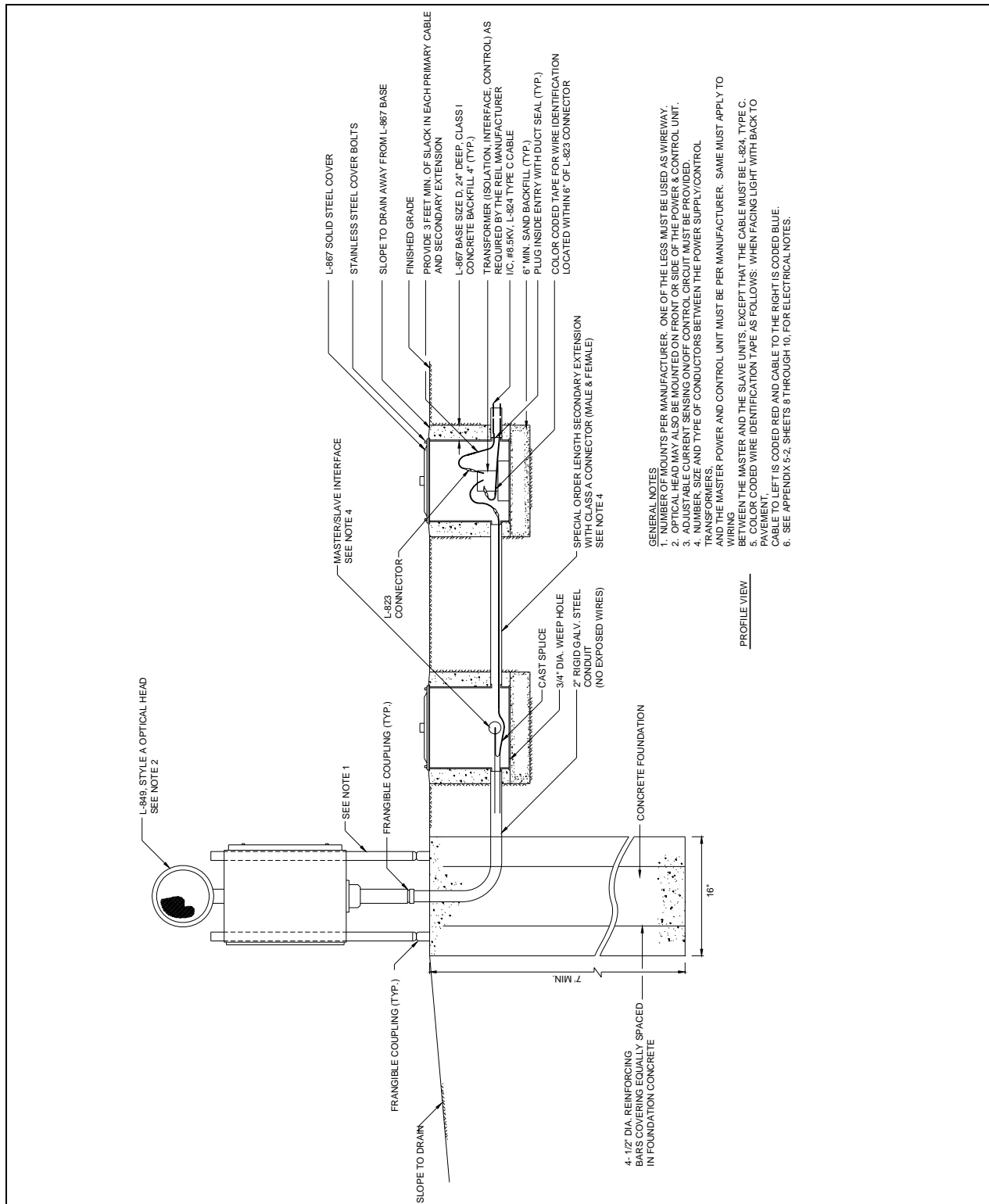


Figure 139. Standard Details for Runway End Identifier Light Power & Control Derived From Runway Circuit – Profile View.

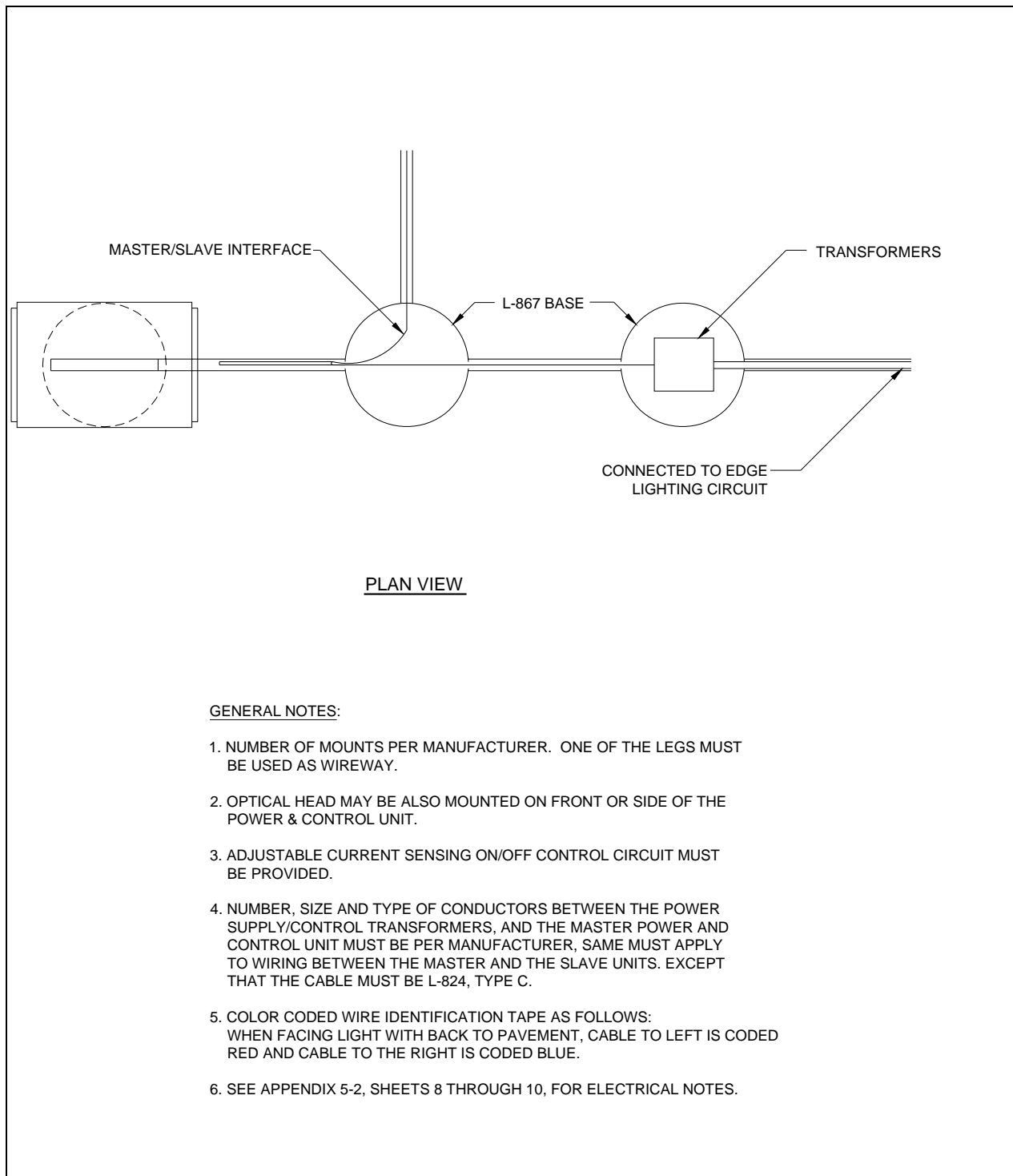


Figure 140. Standard Details for Runway End Identifier Light Power & Control Derived From Runway Circuit – Plan View.

**A5-1. Electrical Notes****a. General**

- (1) The electrical installation, as a minimum, must meet the NEC and local regulations.
- (2) The contractor must ascertain that all lighting system components furnished by him (included FAA approved equipment) are compatible in all respects with each other and the remainder of the new/existing system. Any non-compatible components furnished by this contractor must be replaced by the contractor at no additional cost to the airport sponsor with a similar unit, approved by the engineer (different model or different manufacturer), that is compatible with the remainder of the airport lighting system.
- (3) In case the contractor selects to furnish and install airport lighting equipment requiring additional wiring, transformers, adapters, mountings, etc., to those shown on the drawings and/or listed in the specifications, any cost for these items must be incidental to the equipment cost.
- (4) The contractor-installed equipment (including FAA approved) must not generate any EMI in the existing and/or new communications, weather, air navigation, and ATC equipment. Any equipment generating such interference must be replaced by the contractor at no additional cost with equipment meeting the applicable specifications and not generating any interference.
- (5) When a specific type, style, class, etc., of FAA approved equipment is specified only that type, style, class, etc., will be acceptable, even though equipment of other types, style, class, etc., may be FAA approved.
- (6) Any and all instructions from the engineer to the contractor regarding changes in, or deviations from, the plans and specifications must be in writing with copies sent to the airport sponsor and the FAA field office (ADO/AFO). The contractor must not accept any verbal instructions from the engineer regarding any changes from the plans and specifications.
- (7) A minimum of three copies of instruction book must be supplied with each different type of equipment. The books describing a more sophisticated type of equipment, such as regulators, PAPI, REIL, etc., at a minimum must contain the following:
  - (a) A detailed description of the overall equipment and its individual components.
  - (b) Theory of operation including the function of each component.
  - (c) Installation instructions.
  - (d) Start-up instructions.
  - (e) Preventative maintenance requirements.
  - (f) Chart for troubleshooting.
  - (g) Complete power and control detailed wiring diagram(s), showing each conductor/connection/component "black" boxes are not acceptable. The diagram or the narrative must show voltages/currents/wave shapes at strategic locations to be used when checking and/or troubleshooting the equipment. When the equipment has several brightness steps, these parameters must be indicated for all the different modes.

- (h) Parts list will include all major and minor components, such as resistors, diodes, etc. It must include a complete nomenclature of each component and, if applicable, the name of its manufacturer and the catalog number.
  - (i) Safety instructions.
- b. Power and control
- (1) Stencil all electrical equipment to identify function, circuit voltage and phase. Where the equipment contains fuses, also stencil the fuse or fuse link ampere rating. Where the equipment does not have sufficient stenciling area, the stenciling must be done on the wall next to the unit. The letters must be one inch (25 mm) high and painted in white or black paint to provide the highest contrast with the background.
  - (2) Color code all phase wiring by the use of colored wire insulation and/or colored tape. Where tape is used, the wire insulation must be black. Black and red must be used for single-phase, three wire systems and black, red and blue must be used for three-phase systems. Neutral conductors, size No. 6 AWG or smaller, must be identified by a continuous white or natural conductors larger than No. 6 AWG must be identified either by a continuous white or natural gray outer finish along its entire length or by the use of white tape at its terminations and inside accessible wireways.
  - (3) All branch circuit conductors connected to a particular phase must be identified with the same color. The color coding must extended to the point of utilization.
  - (4) In control wiring the same color must be used throughout the system for the same function, such as 10%, 30%, 100% brightness control, etc.
  - (5) All power and control circuit conductors must be copper; aluminum must not be accepted. This includes wire, cable, busses, terminals, switch/panel components, etc.
  - (6) Low voltage (600 V) and high voltage (5000 V) conductors must be installed in separate wireways.
  - (7) Neatly lace wiring in distribution panels, wireways, switches and pull/junction boxes.
  - (8) The minimum size of pull/junction boxes, regardless of the quantity and the size of the conductors shown, must be as follows:
    - (a) In straight pulls the length of the box must not be less than eight times the trade diameter of the larger conduit. The total area (including the conduit cross-sectional area) of a box end must be at least 3 times greater than the total trade cross-sectional area of the conduits terminating at the end.
    - (b) In angle or u-pulls the distance between each conduit entry inside the box and the opposite wall of the box must not be less than six times the trade diameter of the largest conduit. This distance must be increased for additional entries by the amount of the sum of the diameters of all other conduit entries on the same wall of the box. The distance between conduit entries enclosing the same conductor must of not be less than six times the trade diameter of the largest conduit.
  - (9) A run of conduit between terminations at equipment enclosures, square ducts and pull/junction boxes, must not contain more than the equivalent of four quarter bends (360 degrees total), including those bends located immediately at the terminations. Cast, conduit type outlets must not be treated as pull/junction boxes.

- (10) Equipment cabinets must not be used as pull/junction boxes. Only wiring terminating at the equipment must be brought into these enclosures.
- (11) Splices and junction points must be permitted only in junction boxes, ducts equipped with removable covers, and at easily accessible locations.
- (12) Circuit breakers in power distribution panel(s) must be thermal-magnetic, molded case, permanent trip with 100-ampere, minimum, frame.
- (13) Dual lugs must be used where two wires, size No. 6 or larger, are to be connected to the same terminal.
- (14) All wall mounted equipment enclosures must be mounted on wooden mounting boards.
- (15) Wooden equipment mounting boards must be plywood, exterior type, 3/4 inch (19 mm) minimum thickness, both sides painted with one coat of primer and two coats of gray, oil-based paint.
- (16) Rigid steel conduit must be used throughout the installation unless otherwise specified. The minimum trade size must be 3/4 inch (19 mm).
- (17) All rigid conduit must be terminated at CCRs with a section (10" (254 mm) minimum) of flexible conduit.
- (18) Unless otherwise shown all exposed conduits must be run parallel to, or at right angles with, the lines of the structure.
- (19) All steel conduits, fittings, nuts, bolts, etc., must be galvanized.
- (20) Use conduit bushings at each conduit termination. Where No. 4 AWG or larger ungrounded wire is installed, use insulated bushings.
- (21) Use double lock nuts at each conduit termination.
- (22) Wrap all primary and secondary power transformer connections with sufficient layers of insulating tape and cover with insulating varnish for full value of cable insulation voltage.
- (23) Unless otherwise noted, all indoor single conductor control wiring must be No. 12 AWG.
- (24) Both ends of each control conductor must be terminated at a terminal block. The terminal block must be of proper rating and size for the function intended and they must be located in equipment enclosures or special terminal cabinets.
- (25) All control conductor terminators must be of the open-eye connector/screw type. Soldered, closed-eyed terminators, or terminators without connectors are not acceptable.
- (26) In terminal block cabinets the minimum spacing between parallel terminal blocks must be 6 inches (152 mm). The minimum spacing between terminal block sides/ends and cabinet sides/bottom/top must be 5 inches (127 mm). The minimum spacing will be increased as required by the number of conductors. Additional spacing must be provided at conductor entrances.
- (27) Both ends of all control conductors must be identified as to the circuit, terminal, block, and terminal number. Only stick-on labels must be used.

- (28) A separate and continuous neutral conductor must be installed and connected for each breaker circuit in the power panel(s) from the neutral bar to each power/control circuit.
- (29) The following must apply to relay/contactors panel/enclosures:
  - (a) All components must be mounted in dust proof enclosures with vertically hinged covers.
  - (b) The enclosures must have ample space for the circuit components, terminal blocks, and incoming internal wiring.
  - (c) All incoming/outgoing wiring must be terminated at terminal blocks.
  - (d) Each terminal on terminal blocks and on circuit components must be clearly identified.
  - (e) All control conductor terminations must be of the open-eye connector/screw type. Soldered, closed-eye connectors, or terminations without connectors are not acceptable.
  - (f) When the enclosure cover is opened, all circuit components, wiring, and terminals must be exposed and accessible without any removal of any panels, covers, etc., except those covering high voltage components.
  - (g) Access to, or removal of, a circuit component or terminal block will not require the removal of any other circuit component or terminal block.
  - (h) Each circuit component must be clearly identified indicating its corresponding number shown on the drawing and its function.
  - (i) A complete wiring diagram (not a schematic diagram) must be mounted on the inside of the cover. The diagram must represent each conductor by a separate line.
  - (j) The diagram must identify each circuit component and numbering and color of each internal conductor and terminal.
  - (k) All wiring must be neatly trained and laced.
  - (l) Minimum wire size must be No. 12 AWG.

c. Field lighting

- (1) Unless otherwise notified all underground field power multiple and series circuit conductors whether direct earth burial (DEB) or in duct/conduit must be FAA approved L-824 type. Insulation voltage and size must be as specified.
- (2) No components of primary circuit such as cable, connectors and transformers must be brought above ground at edge lights, signs, REIL, etc.
- (3) There must be no exposed power/control cables between the point where they leave the underground (DEB or L-867 bases) and where they enter the equipment (such as taxiway signs, PAPI, REIL, etc.). Enclosures. These cables must be enclosed in rigid conduit or in flexible water-tight conduit with frangible coupling(s) at the grade or the housing cover, as shown in applicable details.

- (4) The joints of the L-823 primary connectors must be wrapped with one layer of rubber or synthetic rubber tape and one layer of plastic tape, one half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint, as shown in Figure 122.
- (5) The cable entrance into the field attached L-823 connectors must be enclosed by a heat-shrinkable tubing with continuous internal adhesive as shown in Figure 122.
- (6) The ID of the primary L-823 field attached connectors must match the cable ID to provide a watertight cable entrance. This entrance must be encapsulated in a heat shrinkable tubing with continuous factory applied internal adhesive, as shown in Figure 122.
- (7) L-823 type 11, two-conductor secondary connector must be class "A" (factory molded).
- (8) There must be no splices in the secondary cable(s) within the stems of a runway/taxiway edge/threshold lighting fixtures and the wireways leading to taxiway signs and PAPI/REIL equipment.
- (9) Electrical insulating grease must be applied within the L-823, secondary, two conductor connectors to prevent water entrance. These connectors must not be taped.
- (10) Deb isolation transformers must be buried at a depth of 10 inches (254 mm) on a line crossing the light and perpendicular to the runway/taxiway centerline at a location 12 inches (305 mm) from the light opposite from the runway/taxiway.
- (11) Deb primary connectors must be buried at a depth of 10 inches (254 mm) near the isolation transformer. They must be orientated parallel with the runway/taxiway centerline. There must be no bends in the primary cable 6 inches (152 mm), minimum, from the entrance into the field-attached primary connection.
- (12) A slack of 3 feet (0.9 m), minimum, must be provided in the primary cable at each transformer/connector termination. At stake-mounted lights the slack must be loosely coiled immediately below the isolation transformer.
- (13) Direction of primary cables must be identified by color coding as follows, when facing light with back facing pavement, cable to the left is coded red and cable to the right is coded blue, this applies to the stake-mounted lights and base-mounted lights where the base has only one entrance.
- (14) L-867 bases must be size b, 24" (610 mm) deep class 1 unless otherwise noted.
- (15) Base-mounted frangible couplings must not have weep holes to the outside. Plugged up holes must not be acceptable. It must have a 1/4" (6 mm) diameter minimum or equivalent opening for drainage from the space around the secondary connector into the L-867 base.
- (16) The elevation of the frangible coupling groove must not exceed 1-1/2" (38 mm) above the edge of the cover in case of base-mounted couplings, or the top of the stake in case of stake-mounted couplings.
- (17) Where the frangible coupling is not an integral part of the light fixture stem or mounting leg, a bead of silicon seal must be applied completely around the light stem or wireway at frangible coupling to provide a watertight seal.
- (18) Tops of the stakes supporting light fixtures must be flush with the surrounding grade.

- (19) Plastic lighting fixture components, such as lamp heads, stems, frangible couplings, base covers, brackets, stakes, must not be acceptable. L-867 plastic transformer housings are acceptable. The metal threaded fitting must be set in flange during casting process. Base cover bolts must be fabricated from 18-8 stainless steel.
- (20) The tolerance for the height of runway/taxiway edge lights must be  $\pm 1$  inch (25 mm). In case of stake-mounted lights, the specified lighting fixture height must be measured between the top of the stake and the top of the lens. In case of base-mounted lights. The specified lighting fixture height must be measured between the top of the base flange and the top of the lens, thus including the base cover. The frangible coupling, the stem, the lamp housing and the lens.
- (21) The tolerance for the lateral spacing (light lane to runway/taxiway centerline) of runway/taxiway edge lights must be  $\pm 1$  inch (25 mm). This also applies at intersections to lateral spacing between lights of a runway/taxiway and the intersecting runway/taxiway.
- (22) Soil permitting the L-867 bases must not be pre-cast in concrete. Concrete around the bases must be used as a backfill.
- (23) Entrances into L-867 bases must be plugged from the inside with duct seal.
- (24) Galvanized/painted equipment/component surfaces must not be damaged by drilling, filing, etc. Drain holes in metal transformer housings must be made before galvanized.
- (25) Edge light numbering tags must be facing the pavement.
- (26) Cable/splice/duct markers must be pre-cast concrete of the size shown. Letters/numbers/arrows for the legend to be impressed into the tops of the markers must be pre-assembled and secured in the mold before the concrete is poured. Legend inscribed by hand in wet concrete must not be acceptable.
- (27) All underground cable runs must be identified by cable markers at 200 feet (61 m) maximum spacing, with an additional marker at each change of direction of the cable run. Cable markers must be installed immediately above the cable.
- (28) Locations of all DEB underground cable splice/connections, except those at isolation transformers, must be identified by splice markers. Splice markers must be placed immediately above the splice/connections.
- (29) The cable and splice markers must identify the circuits which the cables belong to, such as RWY 4-22, PAPI-4, PAPI-22, etc.
- (30) Locations of ends of all underground ducts must be identified by duct markers.
- (31) The preferred mounting method of runway and taxiway signs is by the use of single row of legs. However, two rows will be acceptable.
- (32) The preferred method to bring the power cable into an L-858 sign is method A, as shown in Figure 126, however, method B is also acceptable.
- (33) Stencil horizontal and vertical aiming angles on each REIL flash head or equipment enclosure. The numerals must be black and one inch (25 mm) minimum height.



- (34) Stencil vertical aiming angles on the outside of each PAPI lamp housing. The numerals must be black and one inch (25 mm) minimum height.
- (35) All power and control cables in man/hand holes must be tagged. Use embossed copper strips attached at both ends to the cable by the use of plastic straps. Minimum of two tags must be provided on each cable in a man/hand hole - one at the cable entrance and one at the cable exit.
- (36) Apply an oxide inhibiting, anti-seizing compound to all screws, nuts and frangible coupling threads.
- (37) There must be no splices between the isolation transformers. L-823 connectors are allowed at transformer connections only, unless otherwise shown.
- (38) Deb splices in home runs must be of the cast type, unless otherwise shown.
- (39) Where a parallel, constant voltage PAPI system is provided, the "T" splices must be of the cast type.
- (40) Concrete used for slabs, footing, backfill around transformer housings, markers, etc., must be 3000 PSI, min., air-entrained.

d. Grounding

- (1) Ground all non-current-carrying metal parts of electrical equipment by using No. 6 AWG bare copper wire to be run inside cabinets and in conduits together with other wires. Where this is not feasible, run the exposed grounding wire parallel or at right angles to the building line and secure it at least every 24 inches (610 mm) and within 6 inches (152 mm) from bend or junction. The exposed wire may be No. 6 AWG if it is not subjected to physical abuse, otherwise No. 4 AWG must be used.
- (2) All ground connections to ground rods, busses, panels, etc., must be made with pressure type solderless lugs and ground clamps. Soldered or bolt and washer type connections are not acceptable. Clean all metal surfaces before making ground connections.
- (3) Tops of ground rods must be 10 inches (254 mm) below grade.
- (4) The resistance to ground of the vault grounding system with the commercial power line neutral disconnected must not exceed 10 ohms.
- (5) The resistance to ground of the counterpoise system, or at isolation locations, such as airport beacon must not exceed 25 ohms.

**Intentionally left blank.**